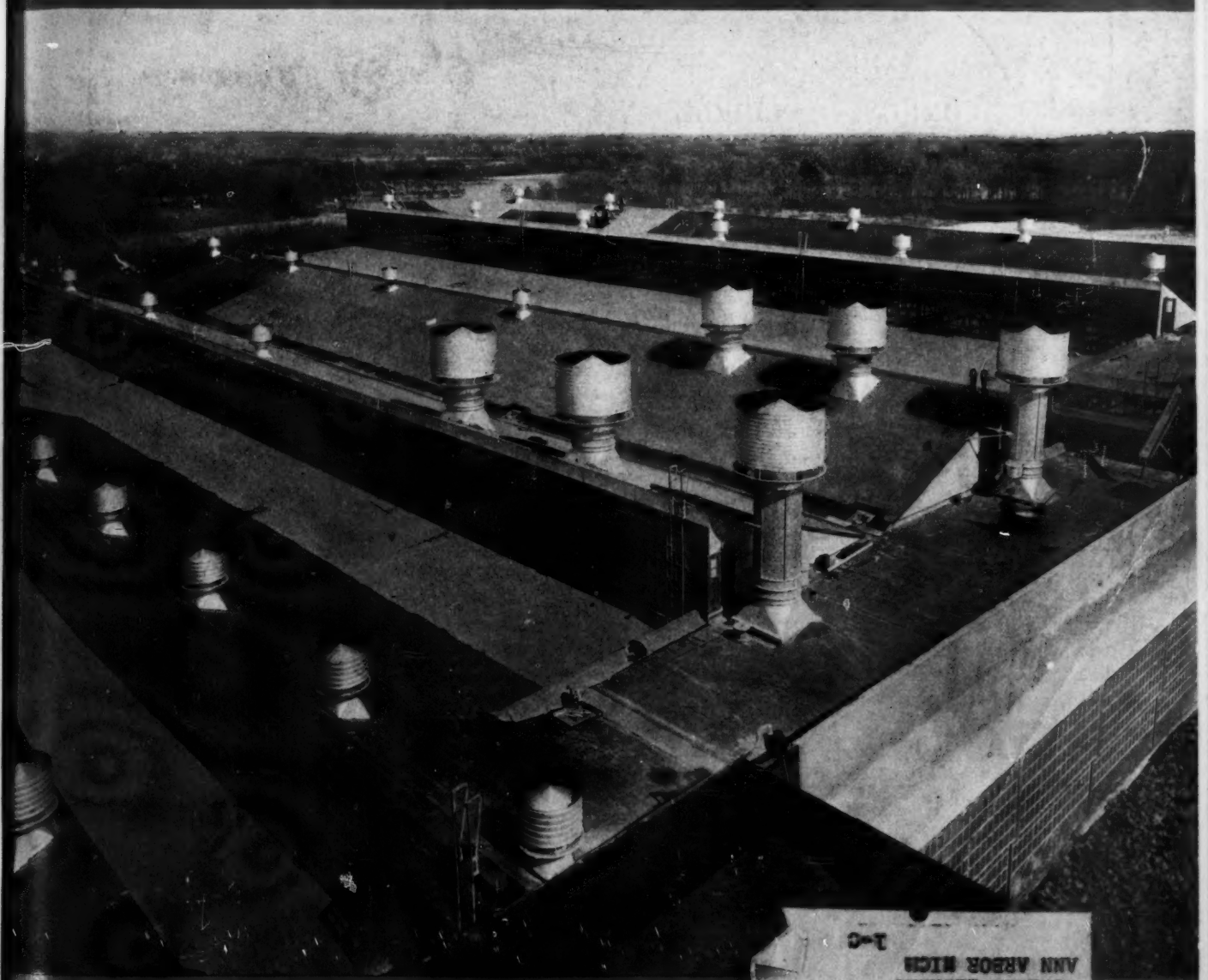
ENGINEERING CONSTRUCTION WEEKLY

ENGINEERING NEWS-RECORD

JUNE 22, 1939

...ot construction on Glenn Martin airplane factory marks completion of one of speediest building jobs on record



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Designers and builders of sewage systems face a double problem . . . to hold first cost to a low figure . . . and still avoid premature replacements and excessive upkeep charges. That the two problems can be reconciled and solved with one material is demonstrated by the Buffalo Sewer Authority. For the large trash rack (29'6" wide) where the Scajaquada Creek flows into the Delavan Avenue storm water relief drain, Byers Wrought Iron was used.

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ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Highways, Streets, Dams, Foundations, Earthwork, Flood Control, Public Works, Irrigations, Canals, Railroads

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THIS WEEK

● High-pressure work was called for in building the 10-acre addition to the Glenn Martin airplane plant at Baltimore between the first of February and the end of April. The article on p. 46 is an example of how properly coordinated designing and construction agencies can be counted on to deliver the goods when time is a controlling factor.

● Sanitary engineers will find up-to-date information on a relatively new method of sewage treatment, the biofiltration process, in the article on p. 51.

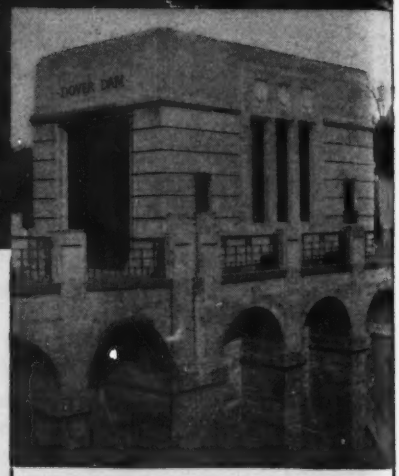
● The biggest earth dam to be built by dry-fill methods is under construction in Tujunga Wash near Los Angeles. Its design is given in this issue, to be followed by an article on the unusual construction methods.

● Reading of the report of the waterworks convention is recommended to men outside the sanitary engineering field. Such things as the suggestion that among the plastics we may discover an ideal material for service pipes, or the discovery that causing a weak electric current to flow from the water in a steel tank to the tank will check corrosion and start the deposit of a protective film cannot but stir the imagination of any engineer who looks beyond his own grindstone.

THINGS TO COME

AMERICAN ENGINEERS often can learn from their brothers abroad. Notable examples of this are found in two coming articles, one on the methods used in building foundations for the Storstrom in Denmark and one on centering for a 460-ft. concrete arch at Berne, Switzerland. At the Storstrom Bridge floating cofferdams were used for the many pier foundations, and the superstructures of the piers themselves were begun on dry land and floated to place on the foundations.

BUILT FOR *lasting* FLOOD CONTROL WITH ARCHITECTURAL CONCRETE



Dover Dam, a Flood Control Project built for the Muskingum Watershed Conservancy District, Ohio, under supervision of the War Dept., U. S. Engineers. Universal Atlas Cement used throughout. District Engineer Major J. D. Arthur, Jr., Resident Engineer: Major W. L. Whittemore. Contractors: Bates & Rogers, Construction Co., Chicago. Close up picture shows some of the design possibilities in Architectural Concrete.

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NEWS

Volume 122 JUNE 22, 1939 Number 25

States Give Consent To Flood Control

Massachusetts and New Hampshire to permit federal land purchase for flood control

Most of the political obstacles which have held up the federal program of flood control in the Connecticut and Merrimac River basins in New England were removed last week when the governors of New Hampshire and Massachusetts both signed state legislation consenting to acquisition by the federal government of land for certain specified reservoirs. The Secretary of War has announced plans for immediate construction on at least two of these.

Work was halted on the New England flood control programs late last December (*ENR*, Jan. 5, 1939, p. 4) and the reason became apparent a few weeks later when Vermont, followed by the other New England states, registered strong protests against the federal flood control program, asserting it violated state's rights (*ENR*, Jan. 19, 1939, p. 35). Vermont still has not given its consent to the federal program.

New Hampshire project

The New Hampshire bill provides for federal land purchase and operation and maintenance of the Bethlehem Junction, Surry Mountain, Blackwater and Franklin Falls reservoirs. The Secretary of War has announced that bids will be asked in the near future on the Franklin Falls Dam, which is located on a tributary of the Merrimac. Early construction of the Surry Mountain reservoir, on a Connecticut River tributary, has also been announced.

Franklin Falls Dam

The Franklin Falls and Surry Mountain work will be under the immediate supervision of Col. A. K. B. Lyman, district engineer at Boston, and Lt.-Col. John S. Bragdon, district engineer at Providence, respectively. The Franklin Falls Dam will be an earth structure with a solid corewall 1,740 ft. long and with a maximum height of 135 ft. Estimated cost is $7,883,000. The Blackwater Dam is in the Merrimac basin and the Bethlehem Junction on the Connecticut watershed.

In Massachusetts, consent is given to federal land purchase for the Birch Hill, Knightsville, Tully and Lower Naukeag reservoirs, all on the Connecticut watershed. The Secretary of War has announced that the Massachusetts law is satisfactory to him and that work will be started soon on the $1,940,000 Knightsville Dam. Estimated cost of the four Massachusetts projects is about $5,750,000.

Work is also expected to start fairly soon on the Birch Hill project, and both this and the Knightsville Dam will be built under the supervision of Col. Bragdon.

• • •

Old Highway Bridge Fails in Ohio

Failure of a 114-ft. bridge over Black Fork Creek on State Route 39 near Mansfield, Ohio, resulted in the death of one man and injury to five others on June 18. Two automobiles were on the steel Pratt truss when it failed. The bridge had a 14-ft. roadway.

The cause of the failure is not yet known, but an investigation is being made by Murray D. Shaffer, division engineer of Division No. 3 of the state highway department. The bridge, which was many years old, was built by the county commissioners of Richland County before the road became a part of the state highway system in 1928.

• • •

Maryland to Enforce Truck Weight Law

Immediate enforcement of the Maryland law limiting trucks to a gross weight of 42,000 pounds has been announced by the new chairman of the state roads commission, Ezra B. Whitman. Whitman said that he believed the present limit is too high and that bad conditions on several main highways in the state can be blamed on failure over the past three years to enforce the weight law.

Prevailing Wage Dropped from WPA

House bill also eliminates large building projects and gives $125,000,000 to PWA

The system under which WPA pays work relief recipients the prevailing hourly wages for their trades and permits them to work only enough hours each month to earn a security wage is eliminated in a bill appropriating $1,477,000,000 to WPA which passed the House last week. The bill has still to be considered in the Senate.

Instead of the prevailing wage system, the new bill would require that relief workers be paid substantially the present monthly amount but that all employees work 130 hours per month with no more than 40 hours per week.

The bill removes large building projects from the WPA program by providing that the WPA build no federally-sponsored building costing more than $50,000 and no non-federal building on which the federal contribution will be greater than $40,000. This limitation applies only to building projects, and other types of WPA projects may exceed these limits.

Public works funds

In order to transfer the large building projects which would otherwise be carried out by WPA to an agency believed by the House appropriations committee to be more suitable, the bill diverts $125,000,000 of the WPA appropriation to the use of the PWA. To prevent this comparatively small amount from being spent on a few large projects, a limit of $225,000 is imposed on the PWA grants which may be made out of this money.

At least 25 per cent relief labor must be used on all PWA projects financed from this fund. Applications for the new PWA grants must be in by Sept. 30; projects must be begun by March 1, 1940 and completed by July 1, 1941. The life of the Public Works Administration is extended to June 30, 1942.

(*Continued on p.* 41)

House Sets Limit On TVA Power Sale

Major changes in authority's powers introduced into Senate bill authorizing utility purchase

A limit was placed for the first time on the geographical area within which the Tennessee Valley Authority may sell its power when the House completely rewrote and last week passed a more or less technical bill which, as passed by the Senate, had simply authorized TVA to purchase some of the facilities of the Tennessee Electric Power Co.

Under existing law, TVA is authorized to issue $100,000,000 of federally-guaranteed bonds, which may be used for the construction of generating facilities and for construction or purchase of transmitting facilities. In order to consummate the purchase agreement with Commonwealth and Southern negotiated last May, TVA had to obtain permission from Congress to use its bonds for the purchase of generating properties. The Senate therefore passed a bill, sponsored by Senator Norris, making this change.

Senate bill rewritten

When the bill was referred to the House committee on military affairs—of which Representative May, an opponent of TVA, is chairman—the committee struck out the Senate bill and substituted its own measure. This was reported to the House June 12 and passed the next day. The bill now goes to conference to settle the differences with the Senate.

The House bill gives the necessary authorization to permit the Commonwealth and Southern deal, but it limits the amount of the bonds TVA may issue to $65,000,000 and requires that they be guaranteed only by TVA instead of by the federal government. TVA is ordered to set up a sinking fund to retire the bonds from electric revenues. The House bill, however, goes much farther than this and makes fundamental changes in the setup of the Tennessee Valley Authority.

Geographical limit

Generation of power by TVA is restricted under existing law to the basin of the Tennessee River, but there is no present restriction upon the area in which TVA may sell the power it generates. The House bill would extend the generation area somewhat by approving the TEPCO purchase and also by authorizing TVA to acquire properties of the Southern Tennessee Power Co. as well as certain utility properties in northern Mississippi and Alabama.

Sale of power, however, is restricted by the House bill to areas which TVA now serves or has contracted to serve and to: the Tennessee River basin; that part of the Cumberland River basin now served by TEPCO; certain enumerated counties in northern Mississippi and Alabama.

The House bill would impose a requirement that Congressional authorization be obtained before TVA constructs or acquires any "dams, appurtenant facilities, generating plants, transmission lines, rural distribution lines, or other electric utility properties." Friends of TVA assert that this provision would cripple the agency by making it impossible to meet conditions as they arise and, perhaps, to carry out ordinary repairs. TVA operates at present under a blanket authorization to develop the Tennessee River and sell the resulting power.

The bill would subject the financial operations of the authority to control by the Comptroller General's office, from which it is now exempt.

Power cost of dams

TVA's dams have been built with money appropriated by Congress. It was the intention that the part of this cost allocated to power be repaid out of power revenues, and this was ensured by a provision that all power revenues above operation cost go into the general funds of the Treasury. The new House bill, instead, would require that the TVA deposit with the Treasury bonds in an amount equal to the power cost of the dams, amortizable over 50 years. This, according to TVA proponents, would hamper the agency by requiring it to begin amortizing its costs before the dams are completed or the power market developed.

Any increase in the payments which TVA now makes to local governments in compensation for tax losses rising from operations of TVA is forbidden in the House bill, "it being the intention of Congress that any such loss in revenue be recovered by the several states involved in such manner as each may see fit from the persons benefited by the use of electric power generated" by TVA.

• • •

Court Upholds F.P.C. On Yadkin Navigability

A finding by the Federal Power Commission that the Yadkin River in North Carolina is navigable is not reviewable by the courts, the U. S. Circuit Court of Appeals at Asheville, N. C. held last week in declining to review an F.P.C. order that the Carolina Aluminum Co. must obtain a license in order to build a dam and power plant at Tuckertown, N. C.

The navigability of the Yadkin is also involved in a suit now pending in the North Carolina courts in which it is being sought to restrain the City of High Point from building a $6,500,000 hydroelectric project on the contention that the city acted illegally in accepting an F.P.C. license.

Bureau of Reclamation photo

SHE'LL BE COMING 'ROUND THE MOUNTAIN

CONTRA COSTA CANAL winds through the foothills of Contra Costa County. About 20 miles of the canal, part of the Central Valley reclamation project in California, is now completed or under construction.

WASHINGTON HIGHLIGHTS

Special reports by Paul Wooton

MERIT RATING systems for collection of premiums on unemployment insurance are likely to be prevented by a provision of the Social Security bill as it passed the House last week. The bill provides that unemployment insurance collection in any state must equal 2.7 per cent of the state's total annual payroll if employers in the state are to obtain credit allowances on federal taxes. Thus, giving preferential rates to employers with good employee turnover records would mean that rates for other employers would have to be boosted above 2.7 per cent, a very difficult procedure.

THE FEDERAL POWER COMMISSION last week issued a comprehensive report giving financial statistics on all the major electric utility companies in the country. Including for the first time uniform and detailed statements of revenues, operating expenses, and classification as well as data on physical characteristics of the 385 privately owned utility companies receiving annual revenues of $250,000 or more, the report is entitled "Statistics of Electric Utilities in the United States—Year Ending Dec. 31, 1937—Classes A and B" and is sold by the commission at $2.

RECOGNITION of the contribution made by Brig. Gen. Harley B. Ferguson to the effectiveness of flood control on the lower Mississippi may take the form of a promotion to the rank of Major General. Support for legislation to that effect is being sought. Several senators have stated that such a bill will have their hearty support. They point out that General Ferguson had the courage to fly in the face of engineering precedent in constructing a series of cutoffs between the Arkansas and Red rivers which have greatly reduced flood heights in that section of the river. Gen. Ferguson will reach the retirement age August 14.

ALLOCATION of funds for projects in the Great Plains program, for which Congress has appropriated $5,000,000, will be made by the President on recommendation of the Department of the Interior concurred in by the Department of Agriculture and the WPA. The Bureau of Reclamation will build the projects and repayment of the cost, which is to be based on ability to pay, will be handled through the Farm Security Administration.

Connecticut to Collect Tolls On Merritt Parkway

On June 21, Connecticut inaugurated the collection of tolls on its Merritt Parkway at a point about 1½ miles east of the New York State line. This innovation became possible when Governor Baldwin signed an act, passed by the recent legislature, authorizing the collection of tolls on the Merritt Parkway, the new Housatonic River Bridge, and a section of the Wilbur Cross Parkway.

The act provides for the collection of tolls on the completed portion of the Merritt Parkway at a station located in the town of Greenwich, and also for the collection of tolls on the Wilbur Cross Parkway at a station in the town of Milford. A second station will be located at a point east of the Housatonic River upon completion of the Housatonic River Bridge, now under construction.

The toll rate has been fixed by the legislative act at 10c per motor vehicle. To provide for motorists who use the Merritt Parkway frequently, special markers will be issed by the state highway department and sold for $10 each. These markers will entitle the motor vehicles for which they are issued to pass a toll station at any time until June 1, 1940.

The revenue obtained from the tolls will be used to defray expenses incurred in construction of the continuation of the Wilbur Cross Parkway to New Haven and eventually to Hartford. From traffic studies made on the Merritt Parkway during the past year it is estimated that an annual income of $500,000 will be obtained.

State Highway Commissioner William J. Cox has placed the making of all arrangements for getting the toll collections started in general charge of William G. Grove, associate highway engineer.

• • •

Traffic Control Plan Drawn for Turnpike

The Pennsylvania Turnpike Commission has appointed Robert S. Holmes of Birmingham, Ala., to formulate a system of traffic control for the South Penn highway which the commission is building between Harrisburg and Pittsburgh. Holmes has just completed a fellowship at Yale University's Bureau for Street Traffic Research.

Tentative plans for the traffic system on the toll road include use of the commission's own police force to patrol the road until it is taken over by the State of Pennsylvania after the bonds are paid off, according to Chairman Walter A. Jones.

Heavy Grouting Stops Tunnel Water Flow

Wet seam halts work on section of Delaware Aqueduct

Some 53 carloads of cement, mixed as grout, was pumped behind a concrete bulkhead before a water flow into the south heading was checked at Shaft 19 on the Delaware River Aqueduct tunnel near Valhalla, N. Y. Though the inflow has been stopped, tunnel progress is still at a standstill pending exploration of the ground ahead by diamond core drilling.

Shaft 19 is a double shaft—independent uptake and downtake shafts with no bottom connection—537 ft. deep. The south heading, leading off the downtake shaft, is about 24 ft. excavated diameter, and had been driven 2,068 ft. when, at 10 p.m. May 17, water broke through the face, bringing in a flow of fine material. Exploratory holes carried ahead of the face had missed the wet seam. The heading was passing from Manhattan Schist into Inwood Limestone; the geologists had predicted a probable fault in the contact zone. A few streaks of limestone had been encountered a short distance back, but the contact was tight. The ground was sound and dry up to the last round or two; steel roof supports had been carried to the face.

The first inflow of 750 gpm increased to 950 gpm in the next 24 hr. Every available pump was brought to the shaft until nine were in service, pumping a maximum of 1,320 gpm. By the time the pumps had caught up with the flow, the tunnel was flooded a depth of 1 ft. 9 in. over top of rail. The heading was pumped out by the morning of May 20.

Sand and concrete bulkheads

To prevent possible collapse of the roof at the face, the contractor built up a timber crib to support the roof steel. Then a sandbag bulkhead 5 ft. high, containing drain pipes, was erected against the face. On May 20 and 21, after the flow was under control, forms were set up for a 16-ft. thick concrete bulkhead, placed 28 ft. back of the face in solid ground. The forms were filled on May 22, and then the void between bulkhead and face was shot full of concrete, giving a solid concrete plug 44 ft. long.

At 8 a.m. May 26 two pumps started forcing grout through pipes extending to the face. Grouting was continuous for 2½ weeks, until finally, at 8:20 a.m. on June 13, the face would take no more under 700-lb. pressure. A total of 63,672 bags of cement mixed

(Continued on page 40)

Hydraulics Conference At Iowa City

Large attendance at S. P. E. E. division meeting discusses an important civil engineering activity

Special Correspondence

The hydraulics conference held in Iowa City, Iowa, June 12–15 under the auspices of the civil engineering division of the Society for the Promotion of Engineering Education and the Iowa Institute of Hydraulics Research enjoyed an unprecedented attendance for such division meetings, total registration reaching 250. The entire proceedings of the conference will be available later from the sponsors in booklet form. Prof. F. T. Mavis, Pennsylvania State College, was conference chairman and Prof. J. W. Howe, University of Iowa, was in charge of local arrangements.

The tone of the conference was set in an early paper by Lt. Paul W. Thompson, Corps of Engineers, who pointed out that the model experimenter, rather than being a theorist only, must be capable of interpreting laboratory observations in terms of practical conditions.

Prof. Hunter Rouse in his paper on Criteria for Similarity in the Transporation of Sediment described experiments which showed that the ratio of the settling velocity of the sediment to the mean velocity of inflow is the essential factor governing the rate of sediment removal. Prof A. A. Kalinske presented a summary of experimental studies of liquid turbulence, including a report of investigations recently made at the University of Iowa, based upon motion pictures from which it was possible to determine the components of turbulence velocities.

Hydro-meteorology is being applied more frequently to engineering problems because of the lack of hydrologic data, it was stated by Merrill Bernard, U. S. Weather Bureau. By including in his studies a consideration of the principal causal factors which are found in hydro-meteorology, the engineer materially improves his statistical analysis of hydrologic problems, he said. W. G. Hoyt, U. S. Geological Survey, characterized the current technique of rainfall-runoff analysis as consisting largely of sifting and resifting a large mass of information. He outlined in a broad way the rainfall-runoff relations during occurrences such as the Ohio River flood of December, 1937 and the Southern California flood of March, 1938.

Dimensional analysis was described by Prof. K. C. Reynolds, Massachusetts Institute of Technology, as primarily a guide in planning a concise experimental program and in analyzing and correlating the observed data. Capt. H. D. Vogel, Corps of Engineers, discussed the problem of geometrical vs. distorted hydraulic models. In the United States in particular, he stated, it has been found necessary to distort the scale because of the lack of topographical relief in many of the river valleys.

The compilation of reports on hydraulic model studies with examples of the type of data to be included and the method of presentation was discussed by Prof. George E. Barnes, Case School of Applied Science. J. E. Warnock, U. S. Bureau of Reclamation, described various methods of energy dissipation and illustrated applications to specific problems, particularly in irrigation systems where many complex situations develop. He also emphasized the difficulties in which designing engineers may find themselves when no model studies are made to determine the basis of design.

The difficulties of obtaining correlation of field and laboratory studies of sand movement along river beds were analyzed by Prof. L. G. Straub, University of Minnesota, in approaching the study of the mechanics of bed movement. The observed and theoretical movement of solid material under field and laboratory conditions were compared by Straub. Prof. E. W. Lane, University of Iowa, discussed suspended load control and the problem of channel stabilization. He described the movements of the particles comprising a suspended load upon the basis of turbulence studies.

Backwater curves which have been constructed to solve various problems of rivers and canals in different sections of the country were reviewed and compared by Prof. C. J. Posey, University of Iowa, who grouped them in two main classes: those in which downstream conditions affect the curve and those in which upstream conditions are controlling. Prof. Harold A. Thomas, Carnegie Institute of Technology, analyzed a special technique of studying waves and pulsating flow in extremely steep channels. These traveling waves sometimes attain such height and velocity as to endanger the structures in which they travel. Flood forecasting in the Upper Mississippi Valley was described by B. S. Barnes, U. S. Weather Bureau, who stated that the two major difficulties encountered are an inadequate number of reporting rainfall stations and an insufficient knowledge of the amount of water absorbed by the soil. Flood forecasting is becoming increasingly important because various structures in cities and towns are being allowed to encroach upon the natural stream chanels.

Heavy Contractors Sign Labor Agreement

Western Pennsylvania group reaches accord with four unions not covering building work

After 30 months of negotiations the Constructors Association of Western Pennsylvania, representing 70 heavy and highway contractors, has signed a closed shop agreement with four labor unions—carpenters, operating engineers, teamsters and laborers. All through the period of negotiations heavy and highway work in the area has been done under closed shop.

The agreement applies to all heavy, railroad and highway construction, but excludes building work, even when performed by members of the association. Outside contractors doing work in the area may come under the agreement.

The four unions include practically all classes of labor used by heavy contractors. Work requiring other classifications must be sublet to contractors normally employing such classes, or done by union labor belonging to the classification. Wage rates are stipulated for every class of labor. Six days of 8 hr. each is the work week, time and a half is to be paid for overtime, Sundays, and holidays, except that workers may make up time lost in any one week during the next two-week period at straight time, not to exceed a total of 10 hr. per day. Maintenance and repair work necessary on Sunday may be done at straight time provided the participating workmen are given some other day off. Hour limits and overtime requirements are suspended in emergencies where life and property are in danger.

Contractors are free to select the men they desire, and employees have the right to choose their employer. If the union cannot supply needed men within 36 hr., the contractor may hire from the outside, but such workers must be discharged or join the union when union men are available. Workers may be temporarily shifted to another classification provided the higher rate is paid.

Board of research

An unusual feature is provision for a board of research, consisting of one representative each from the association and unions, to study economic conditions and to report from time to time as to the advisability of changing working rules, or increasing or decreasing the scales. These reports are advisory only, and action will be taken only by consent of all parties. Strikes and lockouts are barred; all disputes are to be arbitrated.

Annual Awards Made For Steel Bridges

Four bridges were selected this week by the jury of awards appointed by the American Institute of Steel Construction to bear the placque inscribed "most beautiful steel bridge in its class, completed in 1938." In addition, four other bridges were singled out for honorable mention. The jury this year consisted of Graham Erskine, representing Arthur L. Harmon of Shreve, Lamb & Harmon, architects; J. Andre Fouilhoux, architect; David L. Snader, department of civil engineering, Stevens Institute of Technology; Kenneth Hayes Miller, artist; and F. E. Schmitt, editor, *Engineering News-Record.*

First place in Class A, bridges costing $1,000,000 or more, went to the Middletown-Portland Bridge over the Connecticut River at Middletown, Conn.; Total Cost, $3,000,000. Engineers: William G. Grove, under the direction of L. G. Sumner, engineer of bridges and structures, Connecticut state highway department. Fabricator was Bethlehem Steel Co., Owner, State of Connecticut. The main river bridge consists of two tied steel arches of 600 ft. span each. Total length of the bridge, 3,400 ft. (See *ENR* Aug25,1938,p. 236).

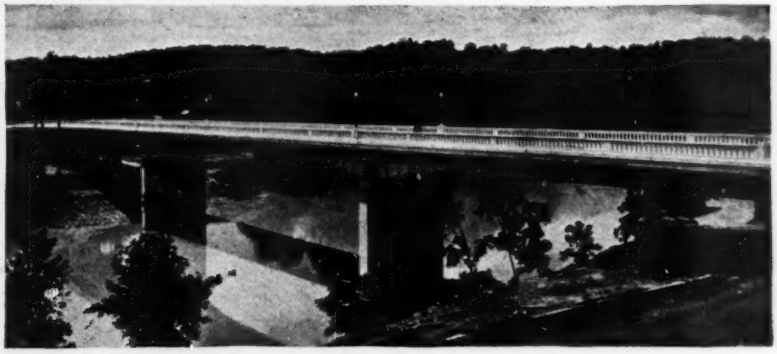
First place in Class B, bridges costing from $250,000 to $1,000,000 went to the Capital Bridge across the Kentucky River at Frankfort, Ky., a continuous steel girder structure. Total Cost, $329,316. Engineers: bridge department, department of highways of Kentucky. Fabricators: Bethlehem Steel Co. Owner, Commonwealth of Kentucky. Span lengths: 3 spans at 67 ft. and a continuous three span unit of 137-200-137 ft. (See *ENR* Oct21,1937,p.672).

First place in Class C, bridges costing less than $250,000, went to the continuous deck truss bridge over the Middle Fork of Flathead River at Belton, Mont. Total Cost, $74,815. Engineers: Montana highway department, B. J. Ornburn, bridge design engineer. Fabricators, Pittsburgh-Des Moines Steel Co. Owner, Montana Highway Commission. Span lengths: 84 ft., 168 ft., 84 ft.

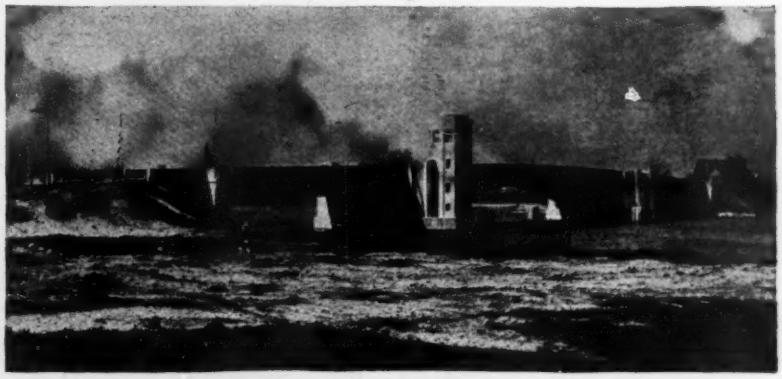
First place in the movable bridge class was awarded the Lafayette Ave. Bridge over the east channel of the Saginaw River at Bay City, Mich. Total Cost, $380,000. Engineers, Hazelet & Erdal. Fabricators: The R. C. Mahon Co., Owner, City of Bay City, Mich. Span length: Bascule span, 185 ft.; approach spans, 97 ft.-10 in., and 108 ft.

Honorable mention in Class A was given the Bluewater Bridge over the St. Clair River between Port Huron, Mich., and Sarnia, Ont., a through, curved-chord cantilever with a 871 ft. main span (*ENR* Aug. 25, 1938, p. 234). In Class B, honorable mention went to the Chain Bridge over the Potomac River between Virginia and the District of Columbia, a long continuous deck-girder bridge (*ENR* May 5, 1938, p. 651). Two bridges received honorable mention in Class C, the 348-ft. span steel rib arch of the Thousand Islands Bridge project over the St. Lawrence River between New York State and Ontario (*ENR*, Aug. 25, 1938, p. 231); and the Burnham Park pedestrian bridge at the foot of E. 47th St. in Chicago, a 115-ft. span welded rib arch (*ENR*, Jan. 5, 1939, p. 25).

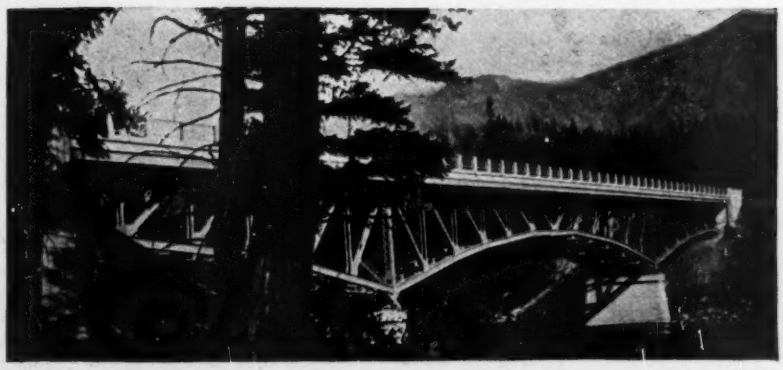
Middletown-Portland Bridge in Connecticut—Monumental class.



Capital Bridge, Frankfort, Ky.—Medium-size class.



Lafayette Ave. Bridge, Bay City, Mich.—Movable class.



Middle Fork of Flathead River Bridge, Mont.—Small-size class.

Water Works Meeting Stresses Economics

Increasing convention size leads to choice of Kansas City for next meeting

Selection of Kansas City for next year's annual meeting of the American Water Works Association was announced at the closing session of the four-day convention in Atlantic City last week. This choice, it was said, reflected the success of this year's convention arrangements which, for the first time, provided auditorium and exhibit facilities at a location apart from the hotel accommodations. Kansas City has a huge municipal auditorium.

The attendance and space occupied by the manufacturers' exhibits at the June 11-15 meeting of the Association in Atlantic City reached an all-time high. *The Waterworks News-Record*, convention daily which has been published by *Engineering News-Record* at these meetings for the last 25 years, reported a listing of about 1,500 delegates and guests. Of this number, paid registrations totaled 1,291.

Jay Herman Smith of the Hershey Mfg. Co. and chairman of the exhibit committee, stated that some 90 manufacturers occupied almost seven acres of display area. This is almost double the space previously taken.

Recovery program

Carl H. Chatters, executive director of the Municipal Finance Officers Association, in addressing the association on the political and social aspects of the recovery program said, "The relief and recovery programs of the federal government have kept people from starving or rioting. But the attempts at recovery have not remedied unemployment. . . . Far too many contradictions and inconsistencies in the program appear to nullify each other. On the other side, many of the broad objectives of the new legislation are highly desirable but need to be refined from an administrative standpoint."

"The authority of local governments," said Chatters, "has been sacked by both the state and federal governments; their revenues have been curtailed and their expenditures increased by pressure groups typified in the first instance by the real estate interests and in the latter instance by road interests and the organized educational lobby. The local governments are now saddled with expenditures to maintain many non-essential public enterprises and the accompanying debt."

Discussing Chatters' paper, Abel Wolman, professor of sanitary engineering, John Hopkins University, said that we are going through a period of "peaceful revolution," and that a subtle change has occurred in our economic, social and political structure. He said that every step of reform has brought intervention from government, and a long period of adjustment must follow these big changes. The period 1930-39 was characterized as one of the most difficult stress periods in our history, and one in which emotion has controlled political action.

Speaking on the increase of centralization in our government, Wolman reminded his listeners that with local autonomy goes local responsibility. If evasion of this local responsibility is continued, as indicated by demands for federal financial aid, communities must likewise be prepared to relinquish local autonomy, he said.

Abstracts of papers presented in the technical sessions of the convention are given on p. 854 of this issue. Highlights of the general sessions, and the names of officers and recipients of awards were given in the June 15 issue, p. 810.

Heavy Grouting Stops Tunnel Water Flow

(*Continued from p.* 37)

with 146,431 cu.ft. of water was pumped into the fault, equivalent to 6,567 cu.yd. of grout, enough to fill the excavated tunnel for a length of 400 ft.

Core drilling operations are now under way, and though the drills had penetrated 125 ft. beyond the face by June 20, conditions of the ground are still indeterminate. Indications are that there is some 75 ft. of very bad ground ahead.

Associated Contractors, Inc., is driving this section of tunnel for the New York Board of Water Supply; E. H. Hatch is general tunnel superintendent and C. D. Riddle is chief engineer for the contractor. Walter E. Spear is chief engineer of the Board of Water Supply; Shaft 19 comes under the supervision of Harry R. Bouton, department engineer, John M. Fitzgerald, division engineer and Irving W. Guttridge, section engineer. Sprague & Henwood is doing the core drilling.

FAST DIRT MOVING FOR WASHINGTON MUNICIPAL BUILDING

WORKING on one of the fastest excavation schedules ever set up for a building job, the foundation contractor on the new District of Columbia Municipal Building in Washington is moving an average of 7,500 cu. yd. of earth per day, even surpassing his own expectations of 125,000 cu. yd. in 20 days. This is being done with four power shovels of 1¼-yd. to 1½-yd. capacity, 75 trucks and two diesel tractors with bulldozers, and no common labor. The laborers are out on strike for higher wages, but other trades are working, and the contractor reports faster progress since the laborers walked out June 5 than he made before.

The entire foundation contract, amounting to $468,000, must be practically complete in 90 calendar days. The job involves 130,000 cu. yd. of general excavation, 4,500 cu. yd. of caisson excavation, 12,000 cu. yd. of concrete and 740 tons of reinforcing steel. Francis M. Tompkins is general superintendent and W. T. Graham is job superintendent for the general foundation contractor, Chas. M. Tompkins Co. of Washington. Walter Potts is superintendent for Potts & Callahan Contracting Co., subcontractor on the excavation.

Electrical Contractors Fined for Collusion

Nine New York City electrical contractors last week received fines of $500 and suspended prison sentences on their plea of guilty to charges of conspiracy to submit collusive bids to New York City and to certain private firms on electrical contracts totaling more than $25,000,000 over the past five years.

The men involved were Frank W. Cooper of the J. G. Livingston Co., Henry Fischbach of Fischbach & Moore, John L. Flagg of Watson-Flagg Engineering Co., Robert A. Goeller of Hatzel & Buehler, Arthur S. Henry of L. K. Comstock & Co., John T. Kallenberg of Watson-Flagg, John G. Livingston of the J. G. Livingston Co., Frederick Lord of the Lord Electric Co., and Loran C. McNutt of McNutt, Watts & Tankard.

• • •

Prevailing Wage Dropped on WPA

(*Continued from p.* 35)

A provision forbids the use of money appropriated in this bill for power plants competitive with private utilities or for competitive factories or mills. This restriction has been applied to WPA in the past but it has never heretofore applied to PWA.

Allocation of funds

For the first time a formula is included for the allocation of relief funds to the states. The bill provides that money be divided among the states based 45 per cent on population, 45 per cent on unemployment in the state and 10 per cent at the discretion of the Works Progress Administration.

Projects sponsored by federal agencies, at first entirely eliminated, were restored during debate but limited to a total of $50,000,000. The bill forbids expenditures for any project sponsored only by WPA, a provision chiefly affecting the arts projects, and forbids any federal theatre program.

Administration of WPA

Under the House bill, WPA would be administered by a three-man board instead of by a single administrator, as at present. Not more than two members of the board could be of the same political party, and appointment to the board would be confirmed by the Senate. The President may appoint an Army engineer as one member of the board without Senate confirmation.

A number of other changes are made in WPA administrative methods, the most drastic of which is a provision that all WPA workers who have been on relief work for 18 months or more be discharged and not be eligible for reappointment for a period of sixty days; it is also provided that the degree of need of every WPA worker shall be investigated at least once each six months.

Relief workers taking temporary private employment which terminates through no fault of their own, the bill provides, will not lose their WPA status.

The bill attempted originally to reduce to $6 the $7 per man-month which WPA is permitted to spend on non-labor costs, but the $7 figure was restored on the floor of the House. An amendment of similar effect which would have forbidden WPA to purchase equipment costing more than $500 per unit was defeated on the floor.

The bill appropriates $750,000 for the use of the National Resources Planning Board, successor under the government reorganization program to the National Resources Committee.

CONTRACTS AND CAPITAL

ENGINEERING construction awards for the week, $40,543,000, are 21 per cent higher than in the corresponding 1938 week, but 27 per cent below a week ago. This is the third consecutive week in which current totals have exceeded their respective 1938 values.

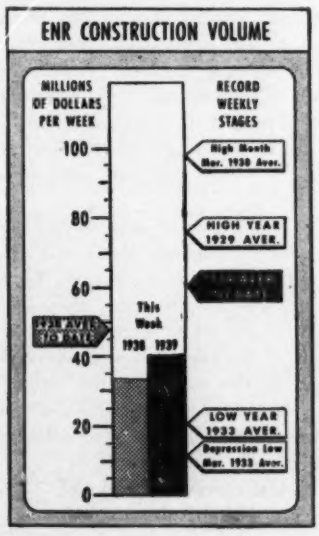
The current week's total brings the 1939 volume to $1,515,324,000, an increase of 27.5 per cent over the $1,187,311,000 reported for the initial 25-week period in 1938.

Private awards for the week are 1 per cent above a year ago, and exceed their last year's values for the third successive week. They are 10 per cent higher than a week ago. Public construction is 31 per cent above last year, but 35 per cent below last week.

In the classified construction groups, waterworks, sewerage, bridges, industrial buildings, public buildings, earthwork and drainage, and unclassified construction top their totals for the 1938 week. Bridges, industrial buildings, commercial buildings and large-scale housing, and public buildings report gains over a week ago.

New capital for construction purposes for the week, $7,419,000, is 72 per cent lower than in the 1938 week. The current week's total is made up of $5,132,000 in state and municipal bonds, $2,272,000 in REA loans, and $15,000 in RFC loans for municipal improvements.

New construction financing for 1939 to date, $907,687,000, is 15 per cent above the $787,999,000 reported for the corresponding 25-week period last year.



CONTRACTS

(Thousands of dollars)

	Week Ending June 23 1938	June15 1939	June 22 1939
Federal	$3,672	$15,495	$5,827
State & Municipal	18,426	29,344	23,114
Total public	$22,098	$44,839	$28,941
Total private	11,474	10,586	11,602
TOTALS	$33,572	$55,425	$40,543
Cumulative 1939 (25 weeks)			$1,515,324
1938 (25 weeks)			$1,187,311

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1938 25 Wk.	1939 25 wk.
NON-FEDERAL	$701,467	$596,260
Corporate securities	181,688	125,015
State & Mun. bonds	341,382	312,500
R.E.A. loans	400	40,073
R.F.C. loans	64,891	2,446
P.W.A. allotments	2,036	.....
U.S.H.A. loans	111,070	116,226
FEDERAL	$86,532	$311,427
TOTAL CAPITAL	$787,999	$907,687

FHA MORTGAGES

	Week Ending June 18 1938	June 10 1939	June 17 1939
Selected for appraisal	$22,090	$23,950	$23,600*
Cumulative 1939 (24 weeks)			$556,141*
1938 (25 weeks)			$422,109

*Subject to revision.

ENR INDEX NUMBERS

Index Base		1913	1926
Construction Cost	June	235.02	112.97
Building Cost	June	196.41	106.17
Volume	May	232	102

COMMENT AND DISCUSSION

Readers' opinions on matters that concern the engineer

The Fort Peck Report

SIR: There is one statement in your comment following the writer's "Letter to the Editor" on Fort Peck published in your issue of June 8, p. 753, which the writer cannot let pass without correction.

You state: "The board centered its study on determining the cause of the failure and *on passing upon decisions already made by the district engineer as to the best method of reconstruction*". The portion of this statement which the writer has italicized is simply not true. The board made the recommendations and the district engineer, the division engineer and Chief of Engineers decided to follow them.

The entire organization and facilities of the Engineer Corps were placed at the disposal of the board and all requests by the board for investigations, test data and detail studies were promptly complied with. In addition members of the board made their own individual studies both as to the cause of the slide and as to reconstruction measures, devoting a very large portion of their total time to such studies. There was no decision by the district engineer prior to the recommendations of the board.

In addition to being untrue, your statement is most unjust to the district engineer, who conducted himself with the utmost discretion and earned the highest esteem of the board under trying conditions.

JOEL D. JUSTIN
Chairman, Board of Consultants, Fort Peck Dam Investigation

We regret that our statement appeared to Mr. Justin to be a reflection upon the district engineer. The statement quoted by Mr. Justin was made not in criticism of the board or of the army engineers but simply as a matter of fact to indicate the general scope of the board's activities. When we said that the board *centered* its study on "passing upon decisions already made by the district engineer" we did not mean that the board did this to the exclusion of recommendations of its own. Such recommendations are contained in the report; but the frequency with which such phrases as "as proposed by the district engineer" appear in the report indicates that, due to the urgency of an early start on the reconstruction work, the district engineer found it desirable to put his ideas for reconstruction into concrete form for submission to the board for its approval. That method appears to be fully justified under the circumstances. The fact that the study had to be carried on in that way was cited as indicating the need for a less restricted study of the slide to determine the full extent of its teachings. EDITORS.

Report on Fort Peck Found Not Convincing

SIR: After the six months' study, the report of the board of consultants on the cause of the flow of the hydraulic fill at Fort Peck Dam (*ENR*, May 11, p. 647) is not convincing. Engineers acknowledge the inherent difficulties and hazards in this undertaking, and the wholehearted cooperation and efficiency of the technical skill of the organization for carrying it out. If, therefore, the unexpected has happened, a thorough diagnostic research of associated data regarding the flow is warranted. Published excerpts from the report are equivocal. However, considering the limited available data, the following general observations are brought forward for discussion without presumption of reflection on the wisdom of the investigating board.

A. The area of operations was explored by borings. Sections show the river trough to be formed by shale rock, which constituted about 15 per cent of the whole area of the foundation at the east end and about 5 per cent at the west end, the balance of the foundation area being unconsolidated sand, interspersed with lenses of gravel, loam and clay.

Below reservoir level (El. 2,117.5) nearly 100 of the exploratory borings punctured the dam foundation (El. 2,015) through the sand to the rock. These borings are not stated to have been plugged to avoid the liability of an artesian water flow by joining the water content of the hydraulic fill.

B. In the tunnel excavation of the treacherous and blocky shale almost every square foot of the roof had to be supported at once to hold it in place. In tunnel No. 1 a badly faulted section was encountered carrying water. This section was near the east abutment, the water in the fault being reservoir level.

C. In controlling the building up of the fill, approximately 85 per cent of the solids were deposited on the beaches through traps in the delivery pipes, and from the ends of the pipes the balance of the desirable fines were discharged upon platforms to segregate by gravity while flowing towards the core pool.

In the comparatively stagnant water, the east end of the core pool was about 3,500 ft. from the sluiceways, so that a large accumulation of colloidal material would most likely take place thereabouts. At the junction with the impervious and irregular rock slope of the east abutment, seepage of the retained water in the fill would be restricted and very slow. Provision for drainage here, as was done, for instance, for the "closure slopes", seems to have been omitted.

The pertinacity of the accumulated colloidal material to retain water would cause the drainage of the core end and sand fill to be sluggish. Thus, a condition of "dilatancy" might be expected.

About 1885 the phenomenon of "dilatancy" was discovered by Osborne Reynolds while experimenting with granular material. Its importance in engineering problems and its application here is shown by the carrying capacity of the saturated beaches and in driving the piles to position through sand. The condition of "dilatancy" is explained in the 1919 report of the original soils committee (Am. Soc. C.E. *Proceedings*, 1912–1925). In the fundamental work of this committee the frictional and other theories of soil resistance were studied with negative results, and the committee recognized research into the characteristics of the soil itself as an essential to any permanent solution of the soils problem.

But the committee was deterred in its progress. Its successors followed the old academic theories with results already anticipated.

D. In the earliest examination of the site seams of bentonite were exposed throughout the shale. Probably it also was found in association with the overburden, which suggests the liability of its presence in the fill. Bentonite has the distinctive property of forming a highly viscous solution in the presence of about ten times its weight of water. More than 50 per cent of its particles are of ultramicroscopic size and much smaller than ordinary clay. Consequently when wet it is a very treacherous and slippery material and must be removed from any structure. If bentonite was present in this watery fill, then it is suggested that the mass flow might be attributed directly to the swelling of this treacherous material, rather than to the failure of the rock foundation upon which the mass slumped.

E. During the year previous to the slide, part of the upstream toe of the fill had been reinforced with a supporting berm to El. 2,112. It is observed, too, that the wheeling motion of the slide about the east abutment, and the floating away of the shell upon it, rather than about the west end of the break, suggests a kick out of the unreinforced portion of the lower slope at a point some distance from the fractured rock foundation of the east abutment.

Further, the high speed in the construction and the drag from the reservoir drawdown on the drainage of the shell added to the forces involved in causing the slump.

Appeal is made that these few suggestions (A to E) be reviewed by a reconvened investigation board and that a thorough study of all the data obtainable be considered and results published for guidance of engineers in the future.

ROBERT A. CUMMINGS
Pittsburgh, Pa.

Engineering in Maryland

SIR: In the May 11 issue, p. 635, is a news item stating that Maryland has eliminated its engineering department.

By the way of comment, may I offer the opinion that I was very much in error when I assumed that the state of Maryland was more of a progressive than that? Since when did any health department or public service department feel so well qualified that they think they can do the work of engineers?

I suppose the Maryland State Health Department will measure the stresses in bacteria when they attempt to build a major highway or a dam. I for one think it is about time for high public officials to let engineering work be done by engineers who know how to preserve life just as well in our way as health department officials are supposed to in their way. Is it not remarkable that we engineers do not to my knowledge ever take over the duties of health department officials or the attorney-general's duties? I think not, for the reason we have our hands full in doing what we are trained for.

ARTHUR FULLMAN
Consulting Engineer
Huntington Park, Calif.

Loads on Spiral Columns

Sir: In reading over my article "Safe Loads for Spiral Columns" (*ENR*, May 25, 1939, p. 65), I was astonished to find that through careless oversight or mental blindness on my part, the factor A_c was omitted from each of the two formulas given in the first paragraph for the core load P_c. Although this error will be obvious to anyone reading the article, it may be worthwhile to call attention to it. Its omission does not, of course, affect the essential part of the article, which is given in the table.

J. P. J. WILLIAMS
Department of Civil Engineering
Cooper Union, New York City

Corrections to a Table

Sir: In the April 27, 1939 issue, p. 606, in the table "Base Rates on Compensation Insurance for Construction," an error was made in giving the date as April 1, 1938, whereas it should be April 1, 1939.

Further than that, while the information accumulated by us for this table was checked by three insurance companies, we are now advised by the National Council on Compensation Insurance that there are several items that are misleading and might cause difficulties to contractors using the rates given.

Item 5, Concrete Work, should state it applies to monolithic structures only, meaning only those structures built entirely of concrete.

Under Items 6 and 11 the word "bldgs." should read "dwellings."

Item No. 10 should be omitted entirely and it should refer to Notice No. 4 reading "Governing classification applies when construction or erection work is being carried on."

Item 28 should have a notice stating that such classification is only available when officers or supervising superintendents have no actual charge of the work, as superintendents actually on the grounds will have to take the governing classification rate.

PETER KES
Herbert L. Jamison Co.
New York City

Architectural Criticism

Sir: The photograph, and cost data, of Frank Lloyd Wright's new building for S. C. Johnson & Son, Inc. (*ENR*, May 11, 1939, p. 637) interested me mightily. I had seen drawings and construction photographs of this plant before, and had come to the conclusion that it would probably prove a little expensive, but had not given the owners credit for such folly as you report.

Mr. Wright has fallen into the common error of architects with grandiose ideas and of the most incompetent speculative builders, of making a most unintelligent use of the most expensive materials. Sound engineering, and good architecture make intelligent use of the most inexpensive materials that can be prudently used. After considerable experience in the design of small houses, I have reached the conclusion that the safest guide to esthetics is in economy. If designs are not pleasing, they are generally found to be both uneconomical and unreasonable.

The whole modernist "bug" in architecture seems to arise from a desire for innovation. Unfortunately for the innovators, there are some things that our forefathers perfected, and we can't do very much about them. We may refine and improve them but, given the limitations of material and service, we make radical changes at our peril.

I think Mr. Wright needs "debunking."

DOUGLAS S. LAIDLAW
Structural Engineer
Toronto, Canada

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F. E. SCHMITT, *Editor* W. C. BOWMAN, *Executive Editor*

V. T. BOUGHTON, C. S. HILL, N. A. BOWERS, W. W. DE BERARD

H. W. RICHARDSON, E. J. CLEARY, R. B. COLBORN, R. H. DODDS

Editorial Offices at 330 West 42nd Street, New York

JUNE 22, 1939

WHEN TECHNICAL MEN become absorbed in economic and labor discussions as did the waterworks men gathered at Atlantic City last week, their interest is a plain index of current trends of thought. Men in all fields are concerned with problems of recovery, of security and of labor relations. But in respect to labor relations waterworks men have a more personal interest, for as custodians of the most vital public service, namely the supply of water, they must protect the service against paralysis by strikes. Though the discussion at Atlantic City failed to suggest ways of assuring this protection, there is little doubt that ways will be found as soon as everyone fully understands the need. Quite aside from the economic papers, however, the strength of the technical program made the A.W.W.A. sessions notable. Important discussions of water hammer, pipe design, service-pipe practice and metal protection distinguished the proceedings, and the meeting in its entirety reflected marked progress in the water field and a refreshing liveness of interest in its engineering and operating problems.

Better Water Distribution

DISTRIBUTION FACILITIES of a waterworks system, representing as they do from 50 to 80 per cent of the total cost, command attention whenever waterworks men meet for discussion of their problems. No exception was made at the A.W.W.A. meeting in Atlantic City. Of special interest was the announcement of a new law of design for cast iron pipe, which permits precise determination of wall thickness on the basis of 13 years' committee research. New information was also presented on water-hammer control in long pipe lines, tending to show that the closing time of a valve can be reduced without raising the water-hammer pressure. Also new, and of vital concern where distribution mains are subject to corrosion or to clogging from after-precipitation of calcium carbonate, was the discussion of a method of stabilizing water with sodium hexametaphosphate. These papers and others reported in our review of the technical sessions of the waterworks meeting (p. 66) focus attention on problems of distribution efficiency which merit continued study.

The Waterworks Exhibit

OCCUPYING ALMOST SEVEN ACRES of space, the manufacturers' exhibits at the American Water Works meeting in the Atlantic City Convention Hall last week reached a new high in volume and instructive value. This occasion, the first on which the association used auditorium facilities at a location apart from the hotel accommodations, marked a departure received with enthusiasm by both exhibitors and visitors. It provided an opportunity to present full-scale demonstrations of equipment and eliminated the crowding and confinement of displays that in recent years has been a severe handicap to easy inspection. With equipment exhibits ranging alphabetically from automatic control devices to zeolite softeners, the waterworks show gave convincing emphasis of the vast scope of the industry and the progressive spirit in which the manufacturers seek to meet new demands.

TVA Limited

LAST WEEK the House of Representatives, in setting limits on the power activities of the Tennessee Valley Authority, moved toward putting that organization on its own feet as a business undertaking. What is to come of the changes inaugurated by the House remains to be seen, but it is to be hoped that the Senate will fall in line. Such action would go a long way toward stabilizing public utility operations in the Southeast and should help improve general business conditions. By limiting the area in which the TVA can seek to supplant existing utilities, the bill removes many uncertainties from utility operation; by requiring the TVA to issue it own bonds without government guarantee and by requiring the TVA to repay the federal government for money expended on its power properties it lays the groundwork for putting the TVA on a par with private utilities that must be able to raise new capital through public confidence in their solvency. The TVA is big enough to do without a nursing bottle and under the limits set by the House it will serve a large enough area to be able to demonstrate what can be done with a large public power system in a fair race with private utilities. Everything possible should be done to make that

race fair, and further expansion of government power development in the Southeast should be checked until there is an opportunity to study the present experiment.

Give Them a Chance

A SMART advertising manager in Des Moines foresaw the opportunity to create public goodwill for his insurance company by providing a stand from which an interested populace might view construction operations on his new home office building, thereby starting the first "Sidewalk Superintendents' Club." The idea was given a big boost when John D. Rockefeller, Jr., built and publicized the first New York construction kibitzers' stand after he had been ordered to move along while watching the work on one of his buildings.

Recently, as guests of the Rockefeller interests, nine representatives of sidewalk superintendents' clubs from Hollywood to Boston met in New York to set up a permanent nationwide organization for the promotion of construction kibitizing. Contractors will miss a bet if they fail to capitalize on this public interest in their work. They should take the initiative in providing opportunities for the public to satisfy its construction curiosity, thereby creating a goodwill impossible to obtain in any other manner.

Long-Needed Reform

CONGRESS has made a beginning on a long-needed reform of work relief and public-works construction by House approval of the relief bill last week. Many flagrant abuses that crept into the WPA system and many destructive effects of employment that were inherent in the system itself will be corrected in whole or in part if the bill is finally enacted.

Definite exclusion of work relief from projects of large size and special skill is among the most important of the changes. This improvement promises to check the steady drift toward converting public-works construction into a relief device and creating progressively greater construction unemployment. Of equal importance are the provisions that require something approaching full-time work in return for the WPA wage, in disregard of misguided labor insistence on union hourly wages, and that place a limit on continuous WPA employment, presumably with a view to urging the workers back toward normal employment.

Provision of a new PWA appropriation, though one of quite modest amount, further shows that the House realizes the superiority of the normal construction system over WPA methods. Since a huge reservoir of PWA projects is already on file in Washington, this fund should be able to get into action quite promptly, with correspondingly immediate effects on employment throughout many fields of industry.

As the bill passes through the Senate, opportunity is at hand for strengthening it further. If the limitation of WPA building operations to projects costing less than $50,000 is extended to all types of construction projects the effect will undoubtedly be salutary. The tendency of city governments everywhere to abandon all public-works construction of their own and turn their improvement work over to the WPA would be further reduced, and a beginning made toward restoring normal governmental responsibilities.

It Can Still Be Done

ANY NOTION that a war emergency requiring large and quick additions to the nation's industrial plant would find the construction industry unprepared can be put away and forgotten. A new airplane manufacturing building for the Glenn L. Martin Co. of Baltimore is submitted in evidence. Consider these facts: Early in February the architect was advised that a new building was wanted. As the designers got busy, an earthmoving contractor began excavation. Other contracts followed; material and equipment orders were placed. By the middle of March over thirty trades were working on the building. Before the first of May, airplanes were being manufactured. In eleven weeks from the time the architect received his commission a two-story modern building covering a 5-acre site was ready to turn out military aircraft or peaceable transport ships.

Such a performance should warm the hearts of construction men everywhere, for they have had too few opportunities to let themselves go on a rush job in recent years. The architects, engineers, contractors, manufacturers and workmen fortunate enough to be connected with such a job have of course a special satisfaction; theirs was the privilege of demonstrating that efficiency in construction is not a lost art. And they and the Glenn L. Maritn Co. can take satisfaction, too, in the fact that this job gave employment and aided business recovery in a much sounder way than if five times as many men had been used in the field and five times as much time had been taken to complete it.

FIG. 1. GETTING READY FOR STEEL AT NORTH END, POURING FOOTINGS AT SOUTH END OF FIVE-ACRE SITE

Airplane Factory Built in Eleven Weeks

Contents in Brief — High-pressure planning and design, coordinated materials supply and construction scheduling, and day and night field work produced a new 10½-acre plant for the Glenn L. Martin Co., Baltimore, in less time than it takes to build the average house. This is the story of one of the fastest building jobs on record and of what went into a modern factory that was needed quickly to meet emergency plane orders.

On April 26, the Glenn L. Martin Co. of Baltimore was building airplanes in a new plant with 10½ acres of floor space which on Feb. 1 did not exist even as a design. Not until Feb. 3, in fact, had anyone later connected with the job, including the Martin engineering department, ever heard that a new plant addition was contemplated. On Feb. 9, excavation for basement and foundation began, the first footing was poured Feb. 14, the reinforced concrete basement and first story floor was finished March 18 and erection of the steel framework started March 21. Walls, roofs, sash and piping followed so rapidly that finishing touches were being put on one end of the 685-ft. building before steel was erected at the other.

The accompanying construction schedule tells the story. Drawn up at the beginning of the job, it is an amazingly accurate graph of what actually was done; a few operations were completed in shorter time than schedule and none was as much as 24 hours behind at any time. No building of such dimensions as this, it is believed, has ever been built so fast.

The new building is not a notable structure from the standpoint of design innovations but it contains a number of interesting features. An addition to present plant facilities, it adjoins the huge assembly building, built two years ago (*ENR*, Dec. 9, 1937, p. 941) whose columnless 4-acre floor is made possible by 300-ft. span roof trusses. The roof of the new building comes only to the bottom of the top row of windows of the assembly building so that ample east light is still available to this structure.

A basic requirement of the new plant was that its floor should be at the same level as that of the assembly building. Since the topography of the site was such that a major filling operation would have been required to place this floor at grade, it was decided, on the score of economy, to excavate a basement and support the floor on columns. Thus, while only 240,000 sq. ft. of production area on one floor was required, some 440,000 sq. ft. on two floors was provided at practically no extra cost.

Reinforced concrete was chosen for basement columns and walls and first floor slab because this type of construction permitted an immediate start to be made. While this concrete work was under way, the structural steel for the top story, whose use was dictated by the long spans required, could be fabricated and ready for swift erection as soon as the first floor slab was finished. Wall materials—steel sash, Gunite and brick—and roof materials—6-in. steel channel deck, ½-in. fiber board insulation and a 15-yr. bonded roofing felt—were chosen because of satisfaction with similar designs in the assembly building and because the materials could be obtained and erected quickly.

Space planning and frame

The new building is 685 ft. long and 300 ft. wide; in addition, where it adjoins the assembly building (that is for the first 450 ft. from the north end) there is a 40-ft. service bay,

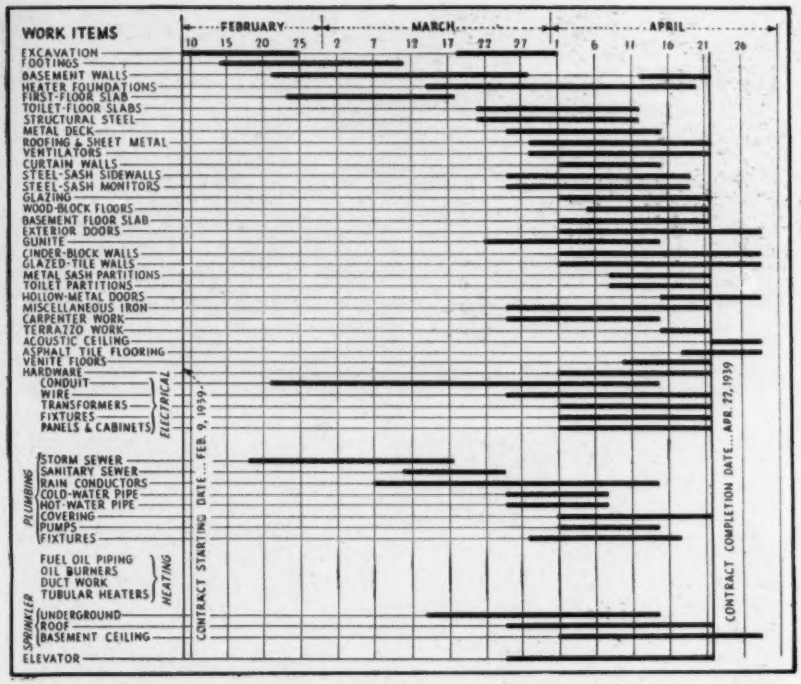

Fig. 2. Production schedule which was laid down at beginning of job and strictly adhered to. Note that the simultaneous operations of over 30 trades had to be coordinated beginning late in March.

which brings the width to 340 ft. In the 685x300-ft. basement, concrete column spacing is on 25-ft. centers both ways to provide efficient size panels for the flat slab floor, while on the production floor the steel columns are spaced 100 ft. transversely and 50 ft. longitudinally, except the two south bays where the longitudinal spacing is 108 and 125 ft. Production lines will advance from north to south so that sub-assembly operations will be handled in the part of the building having 50x100-ft. bays and the larger and final assembly operations at the south end in the 108x100 and 125x 100-ft. bays. The west side of each of these two long bays is closed with record-size hangar doors so that completed planes can be wheeled directly onto the concrete apron.

The concrete floor slab, 10 in. thick, is designed for a live load of 250 lb. per sq. ft. Roof truss framing is unusually light (17 lb. per sq. ft. of floor area) considering the spans involved and the fact that 2,000-lb. concentrated live loads are provided for at panel points of the trusses. Principal aid in securing this lightness is the use of cantilever trusses in the longitudinal direction; monitors run transversely, and each low-roof monitor truss is a suspended span. The welded insulated steel roof deck is also a factor contributing to light weight.

An accordian type expansion joint separates the building into two parts at a point 275 ft. from the north end; trusses span this break by a pin-connected detail. Wall inclosure consists of brick from floor to precast stone window sills and then alternate lines of continuous steel sash and Gunite.

Coolite, a special blue glass, acid-etched both sides, is used on the east, west and south sides of the building to reduce glare and heat transmission.

Special facilities

A factory building such as this requires extensive utility services—water, oil, compressed air, high and low tension power lines and heat. In the existing assembly building the necessary pipes and conduits are carried in trenches beneath the floor slab. However, in the new building advantage is taken of the presence of a basement to hang such lines and conduits from the ceiling, and hundreds of metal inserts for pipe and conduit hangers were cast in the slab on 4-ft. centers for this purpose. An 18x24-in. hole is left in the center of each 25-ft. floor panel through which

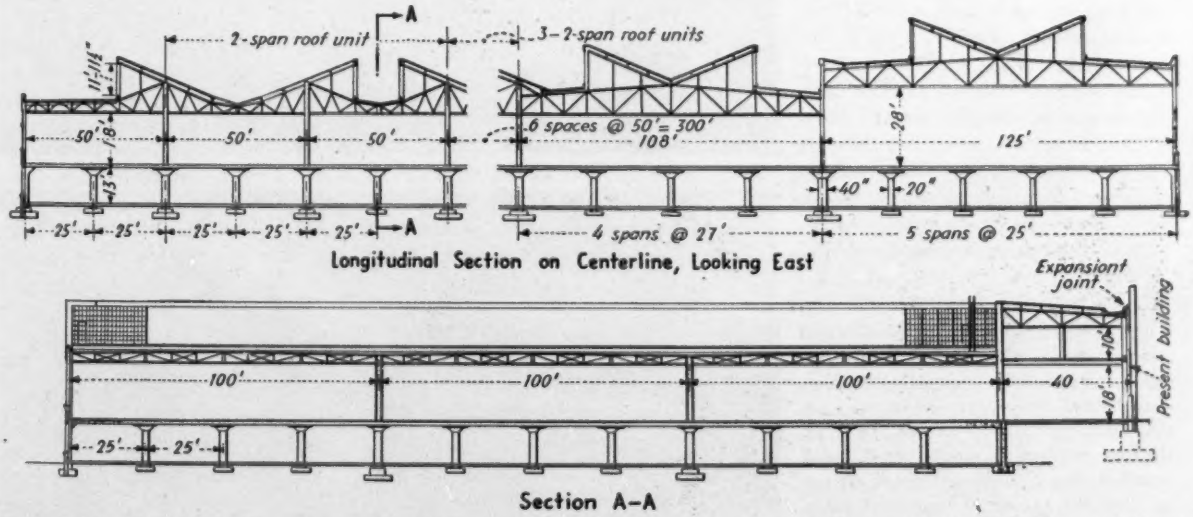

Fig. 3. Framing of new plant is flat-slab reinforced concrete in basement or first story and structural steel above. Cantilever roof trusses aid economical steel design.

these services are brought to the production floor.

It is modern practice in factory construction to place toilet and washroom facilities on a mezzanine above the production floor. In the new Martin building, the toilets are located on a mezzanine but it is a half-story below instead of above the production floor. Seven toilet rooms are used for the five-acre building.

The new building is heated by a type of hot-air system that proved unusually efficient in the existing assembly building. In that structure, air enters through ports along the walls and is exhausted into an under-floor duct along the building centerline. In the new building a reverse direction of flow is used, and hot air in ducts hung from the basement ceiling enters through floor grilles around the interior columns and is exhausted into the basement through floor openings along the walls, the basement acting as a huge plenum chamber. Entrance grilles are arranged to discharge the air at a flat angle to the floor. In addition the aggregate area of exhaust openings is enough greater than the entrances to assure a positive flow of air to them. These two features of the design keep the warm air from rising into the roof where heat is not required. Heat is supplied by 50,000-cu. ft. per min. furnaces, one of which is located in each of five furnace rooms in the basement.

Special structural details are required at the columns to accommodate the hot air inlets. Thus the tops of the concrete basement columns, which support the steel upper-story columns, are built with a well, 2 ft. square and 2 ft. deep, into which the steel column base is set. Holes formed in the concrete column capitals connect this well with the hot air ducts in the basement. The grilles through which air enters the production floor cover the annular space around the steel column set down into this well.

These facilities and details combine

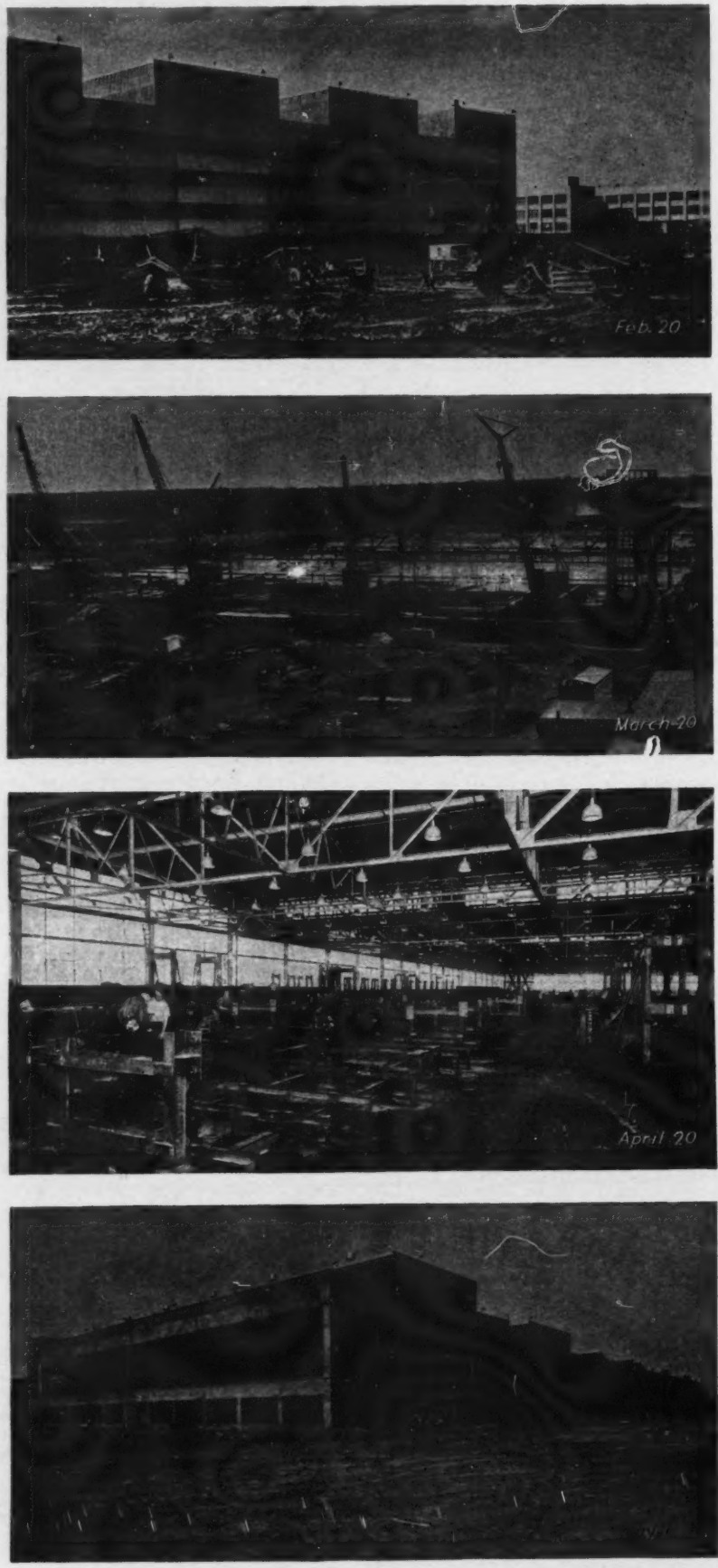

Fig. 4. Fast work. Feb. 20, tractors and scraper wagons doing rough grading as footing construction (at right) follows close behind. March 20, steel erection begins with four crawler cranes. April 20, airplane production machinery is being installed. May 1, finishing touches are put on southeast corner of completed plant.

Engineers and Contractors

Architects and Engineers	Albert Kahn, Inc., Detroit
Field Engineer, Glenn L. Martin Co.	Paul E. Tignor
Excavation	A. V. Williams, Washington, D. C.
Concrete Foundation, Masonry & Carpentry	Turner Construction Co., New York
Structural Steel	American Bridge Co., Pittsburgh
Steel Roof Deck, Sash and Doors	Truscon Steel Co., Youngstown, Ohio
Misc. Iron	Frederich Grund & Co., Philadelphia
Sprinkler System	The Grinnell Co., Providence, R. I.
Electrical Construction	Riggs-Distler Co., Baltimore
Electrical Equipment	Westinghouse Elec. & Mfg. Co., Pittsburgh
Wood Block Flooring	Southern Wood-Preserving Co. Atlanta
Roof Ventilators	H. B. Robertson Co., Pittsburgh
Roofing	Warren Ehret Co., Baltimore
Heating	Lee Heating System, Youngstown, Ohio
Glazing	Chas. Haas, Cuyahoga Falls, Ohio
Railroad and Roadways	Harry T. Campbell & Son, Towson, Md.
Plumbing and Industrial Piping	Lloyd E. Mitchell, Inc., Baltimore
Sheet Metal	J. Brodie & Son, Detroit
Elevators	Otis Elevator Co., Philadelphia
Glass	Pittsburgh Plate Glass Co., Pittsburgh
Air Conditioning	Paul J. Vincent Co., Baltimore
Oil Burners	Todd Combustion Co., New York
Hollow Metal Work	H. B. Brown Co., Baltimore
Hardware	MacCarthy Hardware Co., Baltimore
Metal Partitions	E. F. Hauserman Co., Cleveland

to produce a modern and interesting building, but it is the speed with which it was built that furnishes its chief claim to fame. The story begins with the arrival on a Friday of Albert Kahn, the consulting architect and engineer, with a small staff, which immediately set to work with Paul E. Tignor, Martin's field engineer, to draw the plans. Within 24 hours the American Bridge Co. was awarded a contract for approximately 2,000 tons of structural steel and Truscon Steel Co. was awarded a contract for 800 tons of reinforcing bars. Three days later, foundation excavation began, and a contract was awarded to Turner Construction Co. for the concrete work. Factory orders for materials and equipment were dispatched as fast as drawings came out of the field office, and the job was actively under way on a three-shift basis. Separate contracts were used, all work being coordinated under Mr. Tignor's direction.

General excavation of the site was the first field job attacked. About 83,000 cu. yd. of earth was required to be moved an average distance of 900 ft., the time-schedule allowing 13 days for the work. Six diesel tractors pulling 15-yd. scraper wagons were used, and the work was completed in eight days. Excavation began at the north end, and as soon as a reasonable size area was cut to grade crawler cranes with clamshell buckets moved in to excavate pier footings. At no time were these footings more than 50 ft. behind the rough grading operations. This speed was made possible because the material was clay with only occasional sand pockets and would stand vertically in the hole without sheeting. Footing depth averaged about 4 ft. below the basement level, but in each footing a test hole 15 ft. below the bottom was put down to determine the character of the underlying material.

Concreting

As fast as a hole was completed timber forms, fabricated on the site, were installed, and concreting began. Ready-mixed concrete of high-early-strength cement was used, the trucks chuting the concrete directly into the holes. The 336 footings and columns and the 240,000 sq. ft. of floor slab required a total of 8,000 cu. yd. of concrete which was all in place by March 24.

Structural steel began arriving on the job March 17, five days ahead of schedule. It was brought in on a railroad siding laid the full length of the site along the east building line and unloaded directly onto the floor by a locomotive crane. Erection was by means of four crawler cranes equally spaced across the 300-ft. width of the building. A 36-in. rolled girder beam laid flat furnished a trough support for each crawler. The beams were set on timber blocking on the floor, which was shored in the basement on 12-ft. spans.

Procedure was for the cranes to erect the transverse 100-ft. span trusses in front and back of them and then to fill in the longitudinal trusses and sway frames. To move into the next bay it was necessary to lower the 60-ft. booms to an almost horizontal position. Then, by locking first one crawler and then the other, the cranes were able to slide their supporting beam runway with them until in position for the next set of trusses.

As soon as a 50-ft. length of roof steel was completed by the erecting cranes, the sprinkler pipe contractor moved in, and pipe was often hanging from the roof trusses before they were completely riveted. Roof deck erection and welding followed immediately, while the wall inclosure contractor began as soon as all utilities were in place. Some 240,000 sq. ft. of metal roof deck, 40,000 sq. ft. of steel sash and 42,520 window glass units were required. Also 60,000 brick had to be placed, and the roof covered with 2,379 squares of prepared roofing. Schedule called for the building to be completely inclosed in four weeks from the time of beginning roof and wall erection. The roofer states that normal procedure would have been to use three gangs made up of nine men each whereas seven gangs were employed on this job.

An average of about 500 workers among the various trades and contractors built the building. Maximum number of workers on the job at any one time was 986.

The measure of how rapidly the job progressed and of how coordinated were the operations of the various trades may be noted from the construction progress schedule, which shows that structural steel was completed on April 12, the steel sash and side walls on April 19, and the wood block floor, which was laid at the rate of about 3,000 sq. yd. of block per day, on April 22.

Largest single aircraft plant

The new Martin building cost in the neighborhood of $1,800,000 and is part of an expansion program which also required $900,000 for new machinery and equipment. By this addition the plant becomes the largest single unit aircraft factory in the United States with 1,097,000 sq. ft. of floor space and employment facilities for 10,000 workers. The personnel on May 31 numbered 6,539.

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Chicago's Sanitary Program

The 1939 construction program of the Sanitary District of Chicago amounts to $9,030,000, distributed over the following ten items, as listed in the budget report of William H. Trinkaus, chief engineer: West-Southwest treatment works, $6,830,000; Racine Ave. pumping station, $883,000; Southwest Side intercepting sewers, $390,000; Chicago River controlling works, $210,000; miscellaneous improvements, $717,000. Future work considered essential to the sewage treatment program covers six items and amounts to $14,460,000 (including the items listed above), together with $22,940,000 for nine other items which have been deferred.

Concrete Anchors for Caissons Placed in Circle on Bottom

Deep water and swift currents in Tacoma Narrows led to putting precast concrete blocks on the bottom as anchors for cables holding caissons in place

CONCRETE ANCHOR BLOCKS, weighing 600 tons each, are being dropped in Puget Sound encircling the locations selected for the piers that will support the 2,600-ft. suspension bridge across the Narrows at Tacoma, Wash. Swift currents and hard bottom led to selection of this method as the safest and most economical means of providing anchorages for the large caissons within which the piers will be built.

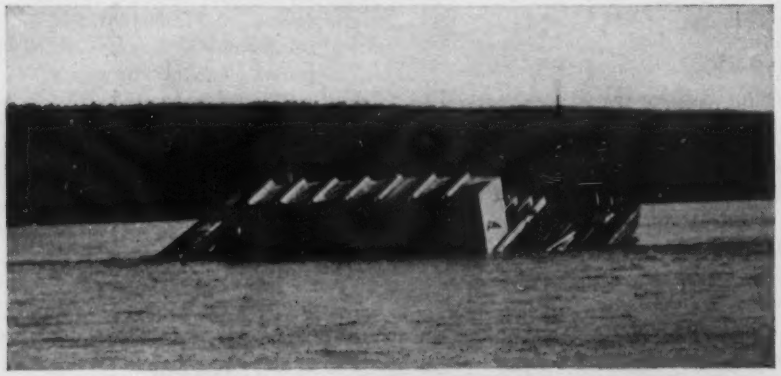
Water depth ranges from 80 to 180 ft., tidal currents are frequently six to ten miles per hour and are not constant as there is much swirling and eddying; the maximum tide range is 17 ft. Under these conditions it was difficult to control the barges from which the anchors were dumped and the work could be carried on only at slack water and on good days.

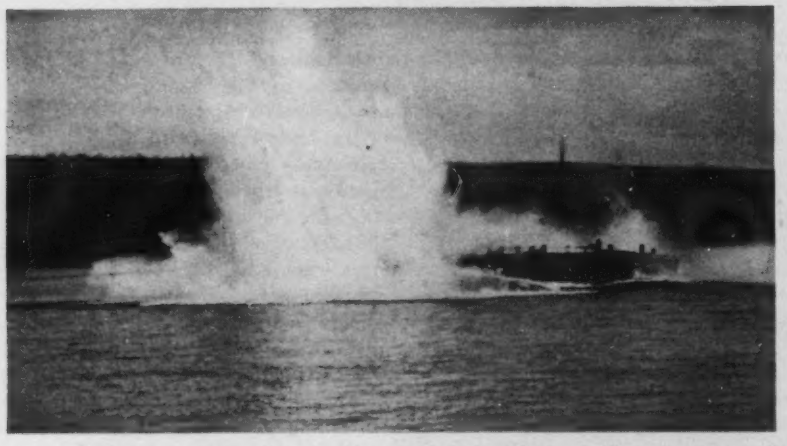
Each caisson will be surrounded by at least 24 concrete anchors placed on the bottom in the circumference of a circle 924 ft. in diameter. The blocks are being placed in groups of two and four, alternately, with groups equally spaced.

Each block is 12x12 ft. in section, and 51½ ft. long with seven transverse ridges on each side to increase resistance to sliding along the bottom. The blocks are heavily reinforced with cable and steel rods as protection against cracking. Each block has two 3-in. U-bolts in the end toward the caisson, to which anchor cables 1-9/16 in. in diameter will be attached.

Placement started with only one tug, then two were used in tandem. The best plan, however, was found to be two tugs operating in such a way as to keep the barge at the peak of a triangle. The barge is "spotted" by two transits on shore and two-way radio is used in maneuvering the barge into place and for giving the order to dump. The anchors are dumped by opening large sea cocks which admit water to longitudinal compartments thus tilting the deck. The anchors make half a revolution between barge and bottom. The "spotting" is considered accurate enough if the block lands within 10 or 12 ft. of the place designated on the chart.

The work is being done jointly by the Pacific Bridge Co., San Francisco, the General Construction Co., Seattle, and the Columbia Construction Co., Portland. C. E. Andrew is directing design and construction for the Washington Toll Bridge Authority. Clark Eldridge is in charge of construction.





The 600-ton blocks to anchor the caissons for the Narrows bridge are dumped from the towing barge by flooding one of the longitudinal compartments.

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Low Runoff Predicted

Forecasts of streamflow in Nevada, based on seasonal snow surveys, indicate that the 1939 runoff will be less than 50 per cent of normal for the streams on the eastern slope of the Central Sierra range. The forecasts are given in a bulletin of the Nevada Cooperative Snow Surveys. In October, 1938, the precipitation was above normal, and snow which fell in November probably remained through the winter on northern slopes above El. 8000. There was little precipitation in December, and that of January, 1939, was considerably below normal. Snow surveys on Feb. 1 indicated a water content of only 18 to 39 per cent of the normal amount due by April 1, although 52 per cent is usually expected. Snow falling in February relieved the situation and the March surveys showed a water content of 40 to 70 per cent of that due for April 1.

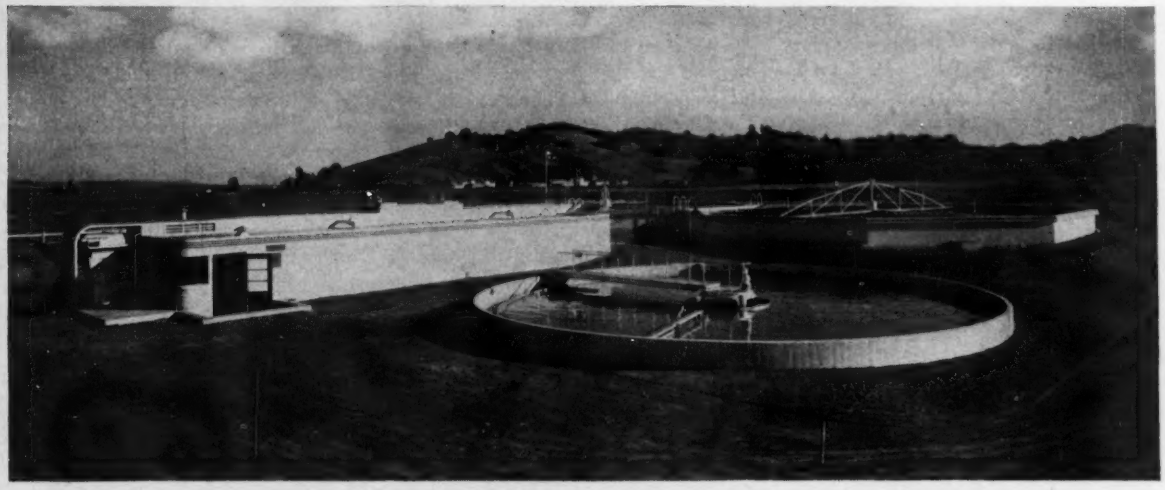


FIG. 1. SEWAGE TREATMENT PLANT AT PETALUMA, CALIF., EMPLOYING THE BIOFILTRATION PROCESS.

Rapid Biologic Filters For A Sewage Plant

HARRY N. JENKS

Consulting Sanitary Engineer, Palo Alto, Calif.

Contents in Brief—Trickling filter processes which operate at rates of flow more than eight times that used in conventional practice are a relatively new development in sewage treatment. This article describes the design and operating features of a municipal installation recently completed in Petaluma, Calif. The author calls the process "biofiltration," and has built ten plants on the Pacific Coast embodying the features described herein.

THE MODERNISTIC DESIGN of the Petaluma, Calif., disposal works reflects the modernity of the bio-filtration process selected for the treatment of domestic sewage and industrial wastes at this small but progressive city. The plant, which includes primary settling, two-stage rapid biologic filters, secondary settling and separate sludge digestion facilities, is designed to treat the waste from 12,000 persons and an industrial population equivalent of 20,000. Average flow to the plant is 0.7 mgd, and the peak flow is 1.25 mgd. The industrial wastes include discharges from two milk product plants, a molasses factory and a silk mill.

The term "bio-filtration" designates the principle of repeatedly passing sewage at high rates of application through a small volume of rock filter medium. The theory and application of the process which combines basic characteristics of the trickling filter and the activated-sludge process were described in *ENR*, May 21, 1936, p. 721. The design and functional characteristics of the first plant ever to be built employing this type of high rate filtration was outlined in *ENR*, July 29, 1937, p. 183.

At Petaluma, sewage is collected in a new intercepting system which terminates at a pumping station. Here it passes through a comminutor before reaching automatically controlled pumps which lift the sewage 12 ft. for gravity discharge into a river crossing leading to the plant.

At the plant the sewage first passes through an automatic bar screen, and it is then lifted 14 ft. to permit gravity flow through the treatment units. The screen is located beneath a shelter at the front of the pumping and control house, which in turn is integral with the digestion tank structure (Fig. 1). A common division wall within this structure provides two independently operable sludge digesters. The tanks are provided with gas collection and heating facilities.

The raw sewage, upon entering the primary clarifier (50 ft. dia. and 8 ft. deep), is immediately diluted with primary bio-filter effluent entering the center feed well (Fig. 2). The sewage then passes through the primary recirculation pump for discharge to and through the rotary distributor of the primary coarse rock bio-filter bed. The effluent from this unit then returns by gravity to the primary detention-settling tank. The flow between the primary and secondary recirculation system responds automatically to that entering the plant, and takes place through the channel connecting the sumps of the recirculation pump. The intermediate location of the third pump sump enables the swing-pump to cooperate with either the primary or secondary stage units, the swing-pump itself being operated by a variable-speed motor.

Partly oxidized effluent from the first stage combines in the secondary recirculation pump sump with the effluent from the detention-settling tank of the second stage and is pumped to and distributed over the fine rock bed

of the secondary bio-filter, the effluent of which flows to the secondary (final) settling tank and back to the second-stage recirculation pump. The plant effluent is discharged over a control sill in an amount corresponding to the volume of flow through the treatment works at any given time.

Filter construction

From the structural viewpoint it is interesting to note that the entire plant is built on timber piling, with the important exception of the bio-filter structures. They were built on consolidated fill placed over the natural ground, taking advantage of the fact that the relatively shallow depth of the bio-filters results in a unit loading of the soil so much less than that of a conventional trickling filter that the piling which would have been required for a structure of the latter type could be eliminated. Incidentally, the foundation area was compacted by means of an explosion ram, or "Leaping Lena."

This procedure was based on a special study and recommendations made by Robert V. Labarre, foundation engineer of Los Angeles.

Each of the bio-filter beds is of 75-ft. diameter inscribed within octagonal enclosing walls. This was more economical than the ordinary circular shape, inasmuch as the walls could be built in straight panels of uniform lengths. Both rock beds are 3 ft. deep.

As shown in Fig. 3A, concrete sleepers were poured in place at 3-ft. centers, extending across the filter floor slab and providing a support for the underdrain grillage. This grillage comprises 2x4-in. irrigation grade redwood, with clear spaces equal in width to that of the 2x4's, and provided with spacer blocks of the same material over each sleeper. The construction details of this type of filter underdrain system are shown in Fig. 3B, together with the method of hand-placing an initial layer of coarse rock that serves as the means of preventing the penetration of the filter material between the 2x4's.

Because the redwood is saturated at all times by the continuous flow of recirculation it is expected to have a useful life equal to that of the bio-filter itself. The nominal load imposed by but three feet of filter material enables redwood to serve adequately as a structural material; and its cost is about one-third that of conventional filter bottoms.

The finished beds and the distribution of the recirculated flow thereon are shown in Fig. 3C. Each of the rotary sewage distributors is of a heavy-duty type, with turntable base and continuous spreader strips along each arm. They have a rated capacity of 2,100 gpm at a loss of head not to exceed 24 in., measured from the surface of the rock bed.

Filter operating features

In keeping with the purpose of stage-treatment the primary biofilter is designed to accomplish chiefly the biochemical flocculation of colloidal matter and the initial reduction of biochemical oxygen demand. The size of the crushed rock of the primary bed is therefore 2½–1½ in. to allow for ample ventilation of the filter material. The secondary biofilter bed is of crushed rock of 1½–1 in. size, to provide as much surface area as practical for further biochemical oxidation of the relatively weak applied liquid from the primary stage, as well as for the production of nitrates in the final effluent.

Since September, 1938, when the plant went into operation, no clogging of either filter bed has occurred, although incipient scattered ponding of the secondary bed takes place at infrequent intervals. It has been found that such ponding is entirely a surface condition, readily eliminated by raking the bed to a depth of 3 or 4 in. Psychoda flies are absent as long as the filter beds are in operation. However, within a few days after a filter is shut down, filter flies appear in the usual numbers characteristic of the ordinary trickling filter, but dis-

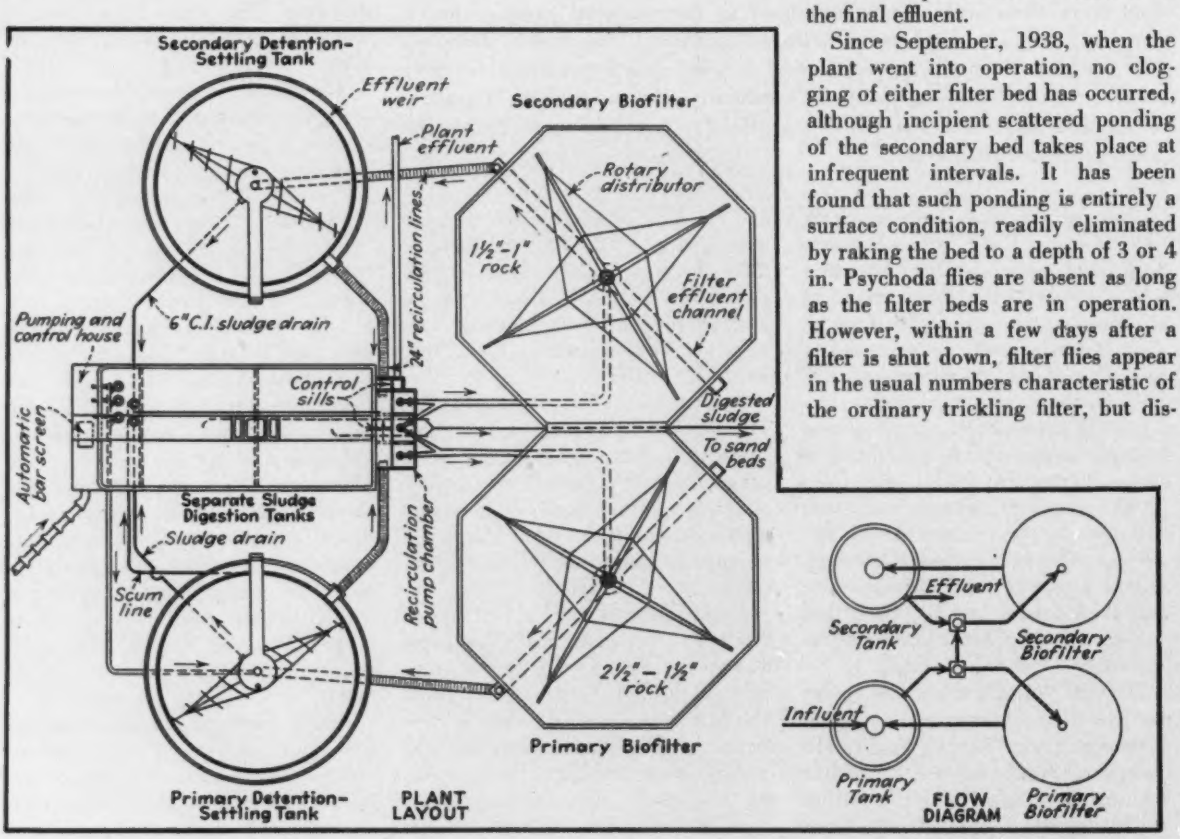
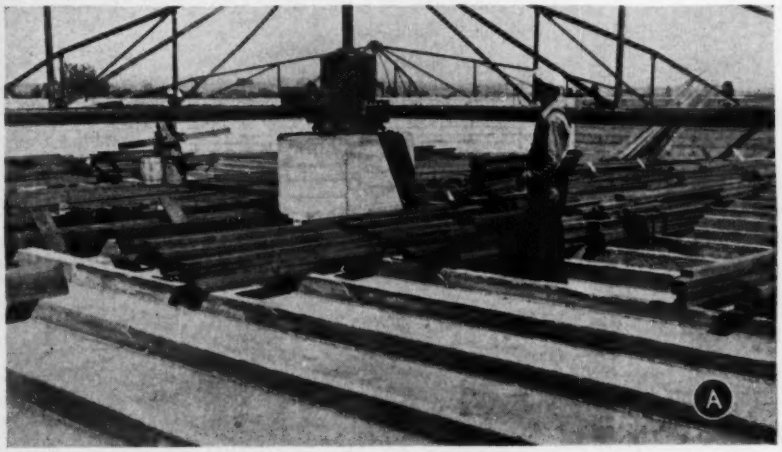


Fig. 2. General layout of the plant units designed for two-stage treatment. A flow diagram is shown on the right.

appear within a couple of days after operation is resumed.

Typical of the bio-filtration process, the recirculation system includes primary and secondary recirculation pumping units and a standby swing-pumping unit, together with interconnecting pipework between the bio-filter beds and the detention-settling tanks, as indicated in Fig. 2. The pump manifold and pressure lines to the rotary distributors are of double dipped and wrapped welded steel pipe; return lines from the bio-filter to the clarifiers are of asbestos-bonded corrugated iron pipe.



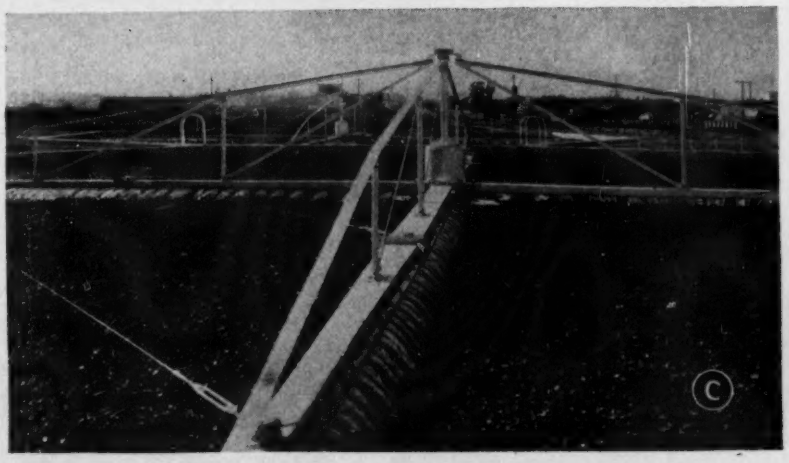


Fig. 3. Bio-filter details: (A) underdrain grillage of redwood lumber over concrete sleepers; (B) hand-placing the initial layer of coarse rock on the grillage; and (C) rotary distributors which provide continuous application of recirculated liquid.

All recirculation pumping units have a capacity of 2,100 gpm against a water-to-water head of 8.5 ft., have a pump efficiency of 82 per cent and are powered by 7½-hp electric motors operating at 1,160 rpm. Each stage thus involves the operation of a 7½-hp motor and affords a recirculation ratio per stage of 3:1 based on the design flow of 1 mgd. By means of the swing-pump, operated by its variable-speed motor, the recirculation ratio may be increased to 6:1 in either stage; or the swing-pump, operating at its full speed, may be used as a substitute for the recirculation pump of either stage in the event of outage for adjustments or repairs.

Power requirements

The power required for the biologic treatment of sewage having a B.O.D. of approximately 300 ppm is 15 hp per million gallons. Measured in terms of a normal flow from the population equivalent of 29,000 or, say, 2.5 mgd, the power requirements for bio-filtration would be 6 hp per million gallons treated. Pending detailed laboratory determinations of the specific purification effected, the operation of the plant has proven adequate to the needs of the local stream sanitation. By comparison with known functional characteristics of bio-filters and the activated sludge process in California, it may be stated that the Petaluma sewage works requires about one-half the power to do the given job that would have been entailed by an activated sludge plant.

The cost of the complete sewage treatment works, exclusive of the pumping plant, was $85,000 to which must be added the cost of piling and soil compaction amounting to about $16,000. The work was financed in part with a grant from the Public Works Administration.

Acknowledgment

Design, construction and initial operation of the entire project was under the direction of the writer as consulting engineer. Harold B. Hammill designed the structural elements and Herbert K. Brainerd was resident engineer throughout construction. Fred J. Early, Jr., was the general contractor on the sewage pumping and treatment works, while the Dorr Co., Inc., the Link-Belt Co., and the Chicago Pump Co. furnished the principal items of equipment installed in the plant.

FIG. 1. SNOW IS FIRST REMOVED TO CLEAR THE ROAD AND THEN PUSHED BACK ONTO THE ROADSIDES (OHIO).

Road Upkeep–A Fight With Storm

C. S. HILL

Associate Editor, Engineering News-Record

Contents in Brief—The fifth of six articles that pictorialize and explain outstanding maintenance activities presents a striking example of mobilization for quick service in snow removal and reducing the hazard of storm.

THE ORGANIZATION of maintenance forces and their equipment for quick mobilization has been emphasized in preceding articles of this series. No better example can be found in all road upkeep activities than the battles to prevent snow blockades in northern winters. This work calls for preparedness and rapid movement of men and equipment. In the text that follows the field procedure described is that in Indiana but the illustrations, properly credited, are selected from operations in others of the four states visited in making the survey for this series of articles.

How snow is conquered

Snow removal is an expected maintenance task and is planned ahead in every state that has much snowfall. And the planning goes much further back than most road users are likely to think is possible, to consideration of snow types, drift formation, wind action, lay of the land, amount of forestation and other particulars. But the basis of practical planning is the state snowfall records, commonly compiled as snowfall maps, an example of which is illustrated by Fig. 2. By these records it is known where snow troubles are most likely to be and must be planned for. This is broad organization work but it is the specific plans that follow which keep the roads clear of snow.

Indiana roads are maintained by the patrol system. Each patrolman has a certain number of roads to maintain, and he generally lives somewhere near the center of his mileage. He has under his jurisdiction, in most instances, one 2-ton truck equipped with a light duty one-way plow; a 3-ton truck equipped with a V-type plow; and spreaders for sanding icy curves and hills, and generally a grader is available for removing snow and ice which has become packed on the roadway under the action of traffic. At the sub-district headquarters the sub-district superintendent has several heavy units with V-plows which he may shift around to meet the emergencies that may arise in any particular locality.

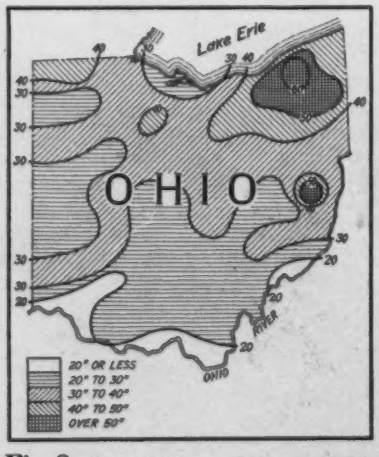


Fig. 2. A typical snowfall map; this Ohio map shows the average annual snowfall in inches as recorded for 37 years.

It will be noted that snow removal calls for special snow-moving equipment, snowplows and tractors and heavy trucks. The maintenance sub-district superintendent usually devotes one of the autumn patrolmen's meetings to outlining and perfecting a plan for snow and ice removal work. This will include schedules of operations and plans for communication between the sub-district office and the snowplow crews. Then before snowfall in the fall of the year all trucks and snowplows are thoroughly checked to see that they are in as perfect a mechanical condition as possible; they must be ready to operate at any and all times. Also, during the fall snow fences are erected. They are placed at points where it is

Fig. 3. Snow fences reduce the chances of drift formation; they are placed parallel to the road in places especially subject to drifting (Pennsylvania).

known that snow will drift badly. Their purpose is to provide a barrier which will break up the wind currents and cause a drift to form between the fence and the road and not on the road. When the storm comes, what?

A snow storm which starts during the day is quite easily handled because the men are out on the road, ready to go to work upon its arrival. One which arrives during the night is the one which requires the cooperation of everyone to mobilize the forces for the safety and well-being of the motorists on the highways.

For the purposes of discussion let us assume that the storm arrives in the middle of the night, at a time when all of the men are off duty and generally abed. It is the practice to cultivate the aid of groups of individuals who are on duty for the full 24 hours. The groups include: the state police, the police of various cities, and attendants at all night filling stations and roadside lunch rooms, which are located on the various patrols. In all cases these groups know the locations of the sub-districts headquarters and oftentimes know the location of the patrol quarters, and they notify one or the other immediately after the snow begins to fall. If the sub-district superintendent is notified first he immediately contacts the patrolmen, checks the condition of their roads and starts the plows. If the patrolman is called first, he immediately contacts the sub-district superintendent, who notifies the rest of the patrolmen, after which he reports the condition of his roads to the district office, which reports to Indianapolis.

By this system all equipment and men in the sub-district territory can be out on the road in a very short time, and this is quite essential in the case of a heavy snowfall. The men are instructed to start the plows as soon as it starts to snow, thereby removing it before it has a chance to drift or pack solid on the pavement. It is much easier to keep the pavement clear by starting in with the snowfall than it is to wait until there are 5 or 6 in. of snow and then try to plow it off. The start is made with light, one-way plows and they are used until it becomes necessary to use the larger trucks equipped with V-type plows.

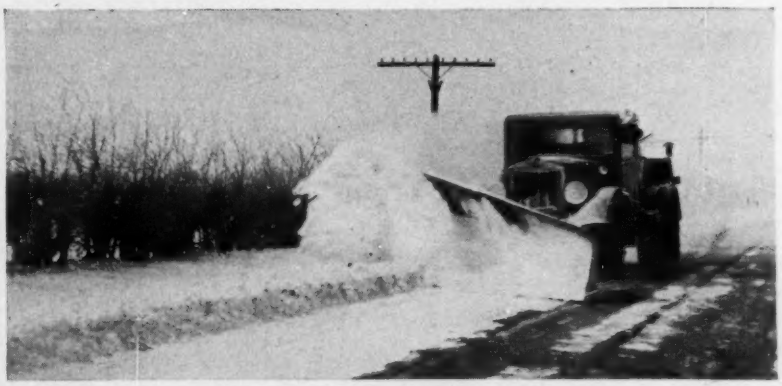


Fig. 4. Straight-blade plows mounted on trucks are the most common machines for removing light dry snow of no great depth (Illinois).

The sub-district superintendent is in constant contact with the men on the road and if any one of them is getting behind, or the road is beginning to drift shut, or the man is in trouble for any reason, additional help is given him by sending out heavy units located at the sub-district headquarters. A snow storm, ordinarily, is not uniform over the entire sub-district and by keeping in touch with the field forces, men and equipment can be shifted to those points where they are needed most.

After the storm subsides the snow is pushed back until it clears the shoulder line. This leaves the entire roadway clear and is a preparatory measure taken in case another snow should soon follow.

Also the condition of the roads is relayed from patrol sections to sub-

Fig. 5. V-plows pushed by powerful tractors take on the road clearing task when the snow is deep and packed hard (Pennsylvania).

Fig. 6. Icy roads are sprinkled with sand or other abrasive material; machine spreaders are rapidly taking the place of men with shovels (Pennsylvania).

district to district to the central office where up-to-date information is kept on whether or not roads are open. Newspapers carry this information and help to educate the drivers not to proceed ahead of a snowplow crew, or if they abandon a car not to lock it as the crews may have to move it from the road to get traffic through. The garage foreman and mechanics are on duty to tune, refuel and repair snow removal units. Relief crews are organized so that no one will work over 12 hr. without rest. Many times the crews on snow removal work become life-saving units as they come upon motorists stalled in the drifts.

Overcoming ice troubles

While most that has been said relates to snow removal, another element of even greater importance is ice. To overcome ice troubles abrasive materials (cinders and sand) are hauled and stocked on all hills and curves. The stockpiles may consist of several cubic yards of abrasives which are stocked at the nearest available location or if the shoulders are wide small stockpiles may be used. It has been found that small stockpiles that can be spread by hand on the most hazardous places are appreciated by truckers as they are the ones who usually block the road by failing to negotiate a hill on account of loss of traction resulting from the presence of ice or snow. Obviously it is impossible for the maintenance patrolman and his forces to be at all the hazardous places simultaneously. The truck drivers appreciate having a small stockpile of ice abrasives available that they can spread by shovels or by hand.

These stockpiles are treated with calcium chloride allowing 50 lb. of calcium chloride to the cubic yard of abrasives. This keeps the piles from freezing solid and aids in melting the ice when it is applied to the road surface with cinders. The maintenance patrolmen are careful not to use enough calcium chloride to damage cement concrete surfaces. Much success has been found in the use of mechanical sand spreaders fastened to the trucks. In most states, these spreaders are replacing hand spreading; they are considerably faster and provide a more even distribution of the abrasives.

Fig. 7. A power shovel is doing the heavy work in making the way clear for Sunday worship at this Pennsylvania country church.

Fig. 8. Shoveling out drift-stalled cars is a particular snow removal duty after every heavy storm (Illinois).

Conclusion

Snow removal is particularly a humanitarian service; it gets doctors to the sick, worshipers to church, newspapers and books to the remote countryside. Every blizzard furnishes its tales of venturesome motorists rescued from the drifts and shut-in families brought food. And the human element of maintenance reaches its peak when floods come, as told in the next and final article.

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Ground at San Jose Now Rising

Latest precise level lines run across the remarkable subsiding area around San Jose, in the Santa Clara Valley, Calif., show a surprising reversal of the subsidence. Repeated precise surveys across that area since 1932 showed a maximum subsidence of about 5 ft. at the center of a bowl-shaped area about 10 miles wide and 30 miles long north and south; the greater amount of the settlement had taken place prior to the first re-running of lines in 1932, but subsequent surveys indicated additional settlement (*ENR*, April 1, 1937, p. 479). In the last year or two, however, settlement has slowed up considerably.

In the re-leveling completed a few weeks ago a rising of the valley floor was observed. "Over a period of a little less than four months the field elevations indicate a maximum average rise of three centimeters," according to a statement by J. H. Hawley, acting director of the U. S. Coast and Geodetic Survey. It is reported that in the neighborhood of the rising ground the artesian water pressure in the valley shows its greatest rise. Since completion of the water storage project in the Santa Clara valley, the impounded water has begun to recharge the groundwater, which had dropped very greatly during the last 15 years. In the opinion of some, the drop in groundwater was a major factor of the ground subsidence, and this view finds support in the fact that rise of groundwater and rise of ground level in the subsidence area are proceeding simultaneously.

Dated Plane Coordinates Needed for Land Surveys

PHILLIP KISSAM,

Assoc. Prof. of Civil Engineering, Princeton University, Princeton, N. J.

Contents in Brief — Some states already have adopted enabling acts for systems of state plane coordinates for use in land survey control, and many other states have such legislation under consideration. As these systems are developed, it will be necessary to make network adjustments, which will mean new sets of coordinates to supersede old ones; this in turn may mean confusion among many of their new users. To avoid this confusion, Prof. Kissam suggests that all coordinates be dated at the time they are entered in public records.

WITH THE DEVELOPING interest in state systems of plane coordinates among engineers throughout the country a question has come up which requires an immediate answer if full benefit of these systems is to be obtained. The question is: "How can new, adjusted coordinates be recorded for general use as they replace older systems?" Obviously, with a change in coordinates, confusion is apt to arise among their users. To care for this situation, dated coordinates are suggested.

State systems of plane coordinates have been designed by the U. S. Coast and Geodetic Survey to provide a means of expressing the positions of extensive control surveys in terms of coordinate systems which require only simple computations for their utilization. Individual surveys can be based on these systems with no added expense for computation, and thus become part of a unified system extending throughout the entire country.

The advantages of basing all surveys on a common horizontal datum are so important and inclusive that it is hardly necessary to refer to them. Rapid mapping by plane table or aerial photography will be available everywhere, compilation of existing maps will be accurate, plans can be drawn with little delay for surveys, and boundary lines of all kinds can be permanently and precisely determined.

But the extensive control necessary for this development must be based on the fundamental triangulation of the United States. Both the fundamental control and the supplementary control will always be subject to development. As more control and greater accuracy is obtained, readjustment of the entire net in various localities will increase the precision of the coordinates of the control markers.

In reconciling the old and new systems, it is first necessary to recognize that a universal datum is highly desirable and that accuracy of control in any locality must be increased from time to time. If these premises are admitted we must agree to occasional redetermination of coordinates.

In many cities local control systems have already been developed. The tenets of good surveying practice require that these control nets and the more extensive nets should either be adjusted simultaneously or the more accurate of the two held fixed. In either case the coordinates will be changed.

A parallel to this problem arises whenever local elevation datums give way to sea level datums in various localities. The procedure adopted for changing over has been nearly always the same. First the two datums are recognized by individual names and on all plans and data records these names are stated. Then an equation is developed to bridge from one datum to the other. The introduction of the new datum proceeds gradually until it has encompassed the whole area.

The same procedure should be applied to the introduction of new coordinates somewhat as follows:

1. While the basic survey data is being obtained and the necessary reductions for changing over are being made all coordinates that are computed should be labeled "future," *and should not be used.*

2. When a sufficient number of new coordinates have been determined a date should be given the adjustment and all the new coordinates obtained through that adjustment should be labeled with that date.

3. The previous coordinates *should not be eliminated* but maintained on all records of survey control points until there is no question that they ever will be needed. This may require several sets of coordinates.

4. Equations for localities should be developed to change from one system to the other. These can be comparatively simple if the area of their application is limited.

5. All maps, plans, and property descriptions should contain only one system of coordinates, and the date of the coordinates should be stated.

Troublesome but necessary

It may appear at first that these suggestions are cumbersome and conducive of errors. There is no question that it would be less difficult and expensive to avoid such changes altogether. But practically this ideal is impossible of fulfillment. Surveys cannot precede by very much the development of the land and, if we are to have the advantages of a universal datum coupled with high precision, a plan of this general type must be adopted at the beginning and followed throughout.

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Water Rises at Boulder Dam

During May, water accumulated in Lake Mead, the 115-mile reservoir behind Boulder Dam, at the rate of 20,000 acre-ft. per day, as compared with 10,000 acre-ft. in May, 1938, the difference being due to the erratic flow of the river, according to a statement issued by the U. S. Bureau of Reclamation. The present total volume is equivalent to 21,720,000 acre-ft. If the rate of rise continues and the level rises to within 21 ft. of the maximum level, it may be possible to test the spillway shafts, which are fitted with drum gates having a vertical lift of 21 ft. The peak volume was 23,190,000 acre-ft. in September, 1938.

FIG. 1. BUILDING HANSEN DAM TO CONTROL FLASH FLOODS ORIGINATING IN THE MOUNTAINS NEAR LOS ANGELES

World's Largest Dry-Fill Dam

Contents in Brief—Hansen Dam, under construction in Tujunga Wash in Los Angeles, will be the largest dry-fill earth dam in the world, containing nearly 13,000,000 cu.yd. As part of the extensive flood control project for the protection of the Los Angeles area, it will create a large detention reservoir to reduce peak discharges in the Wash. Materials for the fill are divided into six zones. River diversion and outlet conduits, passing through the center of the dam, are built as an integral part of the gravity spillway.

IN TUJUNGA WASH, just below the confluence of Big and Little Tujunga canyons at the foot of the San Gabriel Mountains, Hansen Dam is under construction. It is destined to be the largest dry earthfill in the world, and its volume of 12,900,000 cu.yd. is exceeded only by four other earth dams, all of them hydraulic fills—Fort Peck, Kingsley, Gatun and Sardis. The dam is part of the flood control system being developed by the U. S. Army Engineers in cooperation with the Los Angeles County Flood Control District for the protection of Los Angeles and vicinity.

At the site of the dam, Tujunga Wash is a wide, shallow valley that, at times, becomes a waterway for flash floods coming down the two canyons. Normally the stream is but a trickle, and often it is dry, but occasionally it becomes a raging torrent from cloudbursts over a 147-sq.mi. drainage area in the nearby mountains, discharging its flood into the Los Angeles River below.

Hansen Dam will create a flood control basin covering 790 acres and holding 27,600 acre-ft. at spillway crest. It is designed for a 22-ft. surcharge above spillway crest; under such conditions the reservoir would contain 48,100 acre-ft. The basin is figured to take a storm inflow of 64,130 acre-ft. having a maximum peak inflow of 64,800 cfs. As the outflow through conduits beneath the spillway can reach a peak of 12,000 cfs before the spillway is overtopped, the reduction in peak flow will be 52,800 cfs until the reservoir level reaches the spillway. Possibility of the spillway ever going into action is remote.

Normally, little water will stand in the reservoir, as the stream will be carried through two 8x6-ft. ungated concrete conduits. Additional discharge works include eight 5x8-ft. conduits equipped with gates which

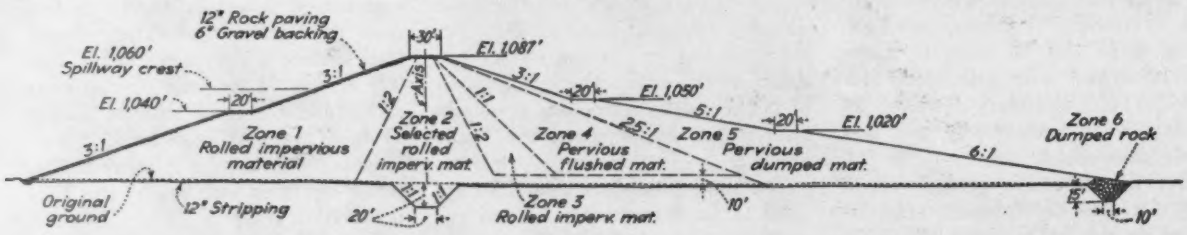


Fig. 2. The 13,000,000-yd. fill forming Hansen Dam will be made up of various materials distributed into six zones. This is a typical cross-section. Note the extension of Zone 2 selected material as a base for Zones 3 and 4.

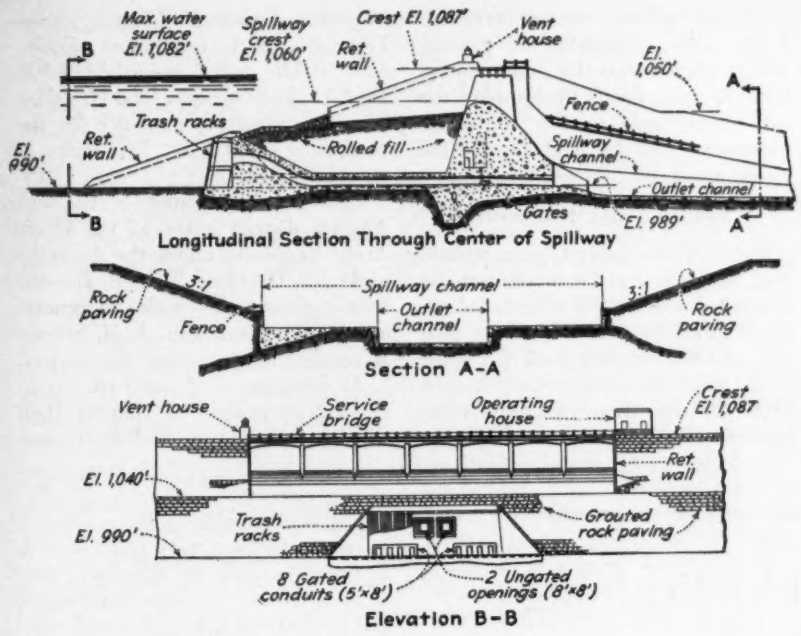


Fig. 3. Combined spillway and outlet works will be built at the center of the embankment. Two of the ten outlet conduits will be ungated to carry normal stream flow.

will be opened as necessary to keep the reservoir from overflowing. The spillway, at the center of the dam, will be a gravity concrete structure of ogee section, 284 ft. long (302 ft. gross with six piers of 3 ft. each) with its crest at El. 1,060, 70 ft. above sill level of the outlet conduits (Fig. 3). Under a 22-ft. surcharge, the spillway will have a capacity of 101,000 cfs.

Design of dam

The dam is a dry earthfill 122 ft. high above river bed (top El. 1,087) with a crest length of 9,050 ft. Embankment slopes are 3:1 upstream and 3:1, 5:1 and 6:1 downstream; the upstream slope will be faced with 12-in. stone paving on a 6-in. gravel blanket.

Foundation preparation consists only of stripping the valley floor a minimum depth of 12 in. Along the axis of the embankment is a cut-off trench of 20-ft. minimum depth and bottom width, backfilled with impervious material; at the embankment abutments where foundation rock is relatively close to the surface, concrete keywalls seal the fill to the rock. Otherwise there is no cutoff under the dam.

Fill material is divided into six zones or classes, as shown in Fig. 2. The embankment in Zones 1, 2 and 3 is of impervious materials spread and rolled in 6-in. layers, with sufficient moisture added to obtain maximum compaction. Material for Zone 2, which forms the real core of the dam, differs from that in Zones 1 and 3 only in that it is more carefully selected for its impervious qualities. Specifications call for a minimum of eight rollings with a sheepsfoot roller for each compacted layer; additional rollings if required are paid for at a unit price. Material in Zone 2 is compacted to a greater consolidation than in the adjacent zones.

Zones 4 and 5 are of pervious material. In the former the material can be spread in layers up to 48 in. thick, then flushed with water to obtain some compaction. Material for Zone 5, the coarsest obtainable, can be placed by any method and up to any depth desired by the contractor subject to the approval of the district engineer. Zone 6 is a rockfill at the downstream toe, specified to be of "well-graded rock in sizes ranging from 75 lb. to 1,000 lb." Suitable materials for all zones except Zone 6 are available within the reservoir area.

River diversion and control

The spillway is being built to one side of the streambed on a rise of sandstone in the valley floor. Beneath the spillway are the ten rectangular concrete outlet conduits to be used for flood regulation. They will be used for stream diversion during construction. Until these conduits are ready, fill is being placed west of the spillway only, as the stream now occupies part of the east side of the valley.

All of the principal structures in the spillway rest directly on rock. Some of the minor walls and slabs will be seated on overburden or compacted backfill. The highest sections

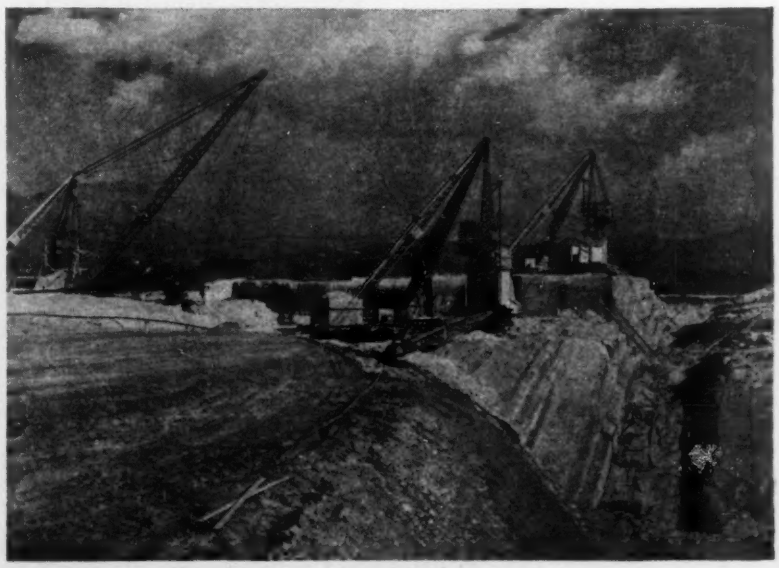


Fig. 4. Deep cutoff trench through the spillway area. The sandstone rock must be protected with Gunite upon exposure to prevent further disintegration.

of the spillway walls are cantilevered from the mass abutment blocks of the ogee section. Low walls, combined with slope paving, form the downstream spillway channel. The structure containing the trashracks and forming the intake to the control conduits is a separate gravity structure, upstream from and connected to the spillway by concrete conduits.

The contractor may build any type of cofferdam he desires for protection of the borrowpits and low portions of the fill. The cofferdams must keep the borrowpits of materials for Zones 1, 2 and 3 dry. Specifications require that the cofferdams provide protection of the structures to El. 1,014, and be capable of passing 10,000 cfs through the outlet works. Damage from floods overtopping the cofferdams built to the above requirements will be paid for by the government.

Contract and direction

Bids for the project were opened Aug. 8, 1938, and the work must be completed within 915 calendar days, after notice to proceed, under penalty of $500 per day until the work is in safe operating condition and $100 per day thereafter until completion. Contract was awarded the Guy F. Atkinson Company, San Francisco, on the low bid of $5,688,419. (Unit prices published *ENR*, Sept. 15, 1938, p. 16). Geo. H. Atkinson is construction manager for the contractor and A. E. Holt is superintendent.

Plans were prepared in the Los Angeles district office of the U. S. Army Engineers under the direction of Major Theodore Wyman, Jr., district engineer, who is also in general charge of construction. A. H. Steiner is resident engineer on the project.

A description of unusual earth-moving operations at Hansen Dam will be published in the July 6 issue.

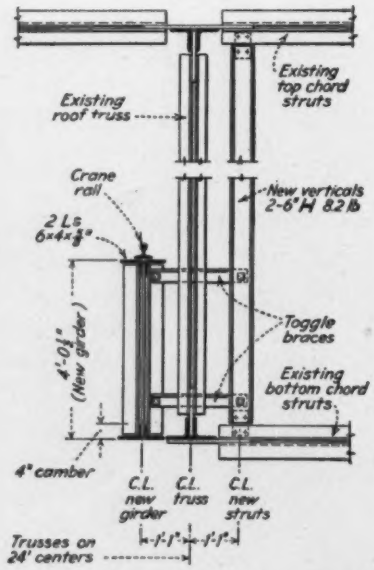
Steel Girder 136 Ft. Long Tied to Bracing for Stability

Provision for 12-ton load between roof trusses of motion picture stage is made by girders which use toggle bracing to resist overturning moment

A PAIR OF STEEL GIRDERS 4 ft. deep and 136 ft. long was found to be the logical solution of a structural problem in an indoor, sound-proof stage of a Culver City motion picture studio except that resistance to overturning was lacking. The girders were used and support against overturning was provided by horizontal connections to the sway bracing in the roof truss system, made in such a way that no vertical load could be transmitted to the existing roof trusses, which were already fully loaded.

The problem arose from the need for an overhead crane to support dummy airplanes for special effects in motion picture filming. Clearance requirements prevented using any support that would project below the bottom chord of the roof trusses. Moreover, only girders of shallow depth could be used above that level because stage lighting equipment depended upon using a certain amount of available head room between roof trusses. The long plate girders 4 ft. deep would just suffice as supports for the rails of the crane of necessary capacity on a 21-ft. 10-in. gage.

Accordingly, plate girders were built up of 48x$\frac{5}{16}$-in. web plates and four 6x4x$\frac{5}{8}$-in. angles with the customary stiffeners. The girders were designed for a maximum deflection of 4 in. at span center when fully loaded. For convenience in handling they were fabricated in half-span lengths and field splices were put at mid-span.



Girder section showing arrangement of horizontal toggles that tie the new girders to the old sway bracing system.

To provide lateral support for these girders without restricting deflection under load, two 6-in. steel channel struts were used as posts, which were secured to existing top and bottom roof struts on 22½-ft. centers. Between these new vertical members and the long girders, toggle braces were put in in pairs, each brace consisting of a pair of 3½x2½x$\frac{5}{16}$-in. angles. These horizontal ties were secured to posts and girders by loosely fitted machine bolts 1 in. in diameter. With this arrangement the 4-in. maximum deflection could occur without pulling the girders out of plumb to any appreciable degree.

This solution of the problem and details of design were worked out by the structural engineering department of the Metro-Goldwin-Mayer Corp., Culver City, Calif.; Cyril P. Hubert, structural engineer; Consolidated Steel Co., steel fabrication.

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Water for Air Conditioning

Consumption of water by individual air-conditioning plants at Indianapolis, Ind., appears to be decreasing, according to a statement in the 1938 report of the Board of Public Works and Sanitation. While the number of plants or units in 1938 was 287, as against 186 in 1937, the increase in total consumption for this purpose was only from 526,145 to 617,437 gal. per hour, or a decrease from 2,819 to 2,150 gal. per hour per plant.

Grouting With A Cement Gun

R. C. KEEFER

Aluminum Company of America, Pittsburgh, Pa.

Contents in Brief — Gives details of pipe-line and control-valve arrangement in remodeling a cement gun for pressure grouting direct from a portable compressor.

THE ACCOMPANYING DIAGRAM shows how a cement gun was remodeled to make pressure grouting repairs to a railroad-bridge pier in northern New York State. The work was done some time ago but the equipment arrangement is as applicable today and offers the possibility, by a few simple homemade changes, of putting a familiar tool to double use.

During the winter, the bridge pier in question and shown by Fig. 1, had shifted or tipped downstream, due to ice action, and had thrown the railroad track and the top of the trusses about 2 in. out of line. In the following summer, when it was found that the stone pier was hollow in the center and that the concrete footing was cracked, pressure grouting repairs were undertaken to prevent further failure. As shown by Fig. 2, ten 2½-in. holes were drilled from the top of the concrete footing, diagonally downward to within 18 in. of the bottom and a second set of eight 2½-in. holes was drilled diagonally downward through the bottom two courses of stone and into the top of the concrete footing of the bridge.

About 18 cu.ft. (dry measure) of cement grout was forced into the first set of holes, and 21 cu.ft. into the second set, but most of this latter batch went into the hollow core of the stone pier. Reinforcing steel bars, ⅞ in. in diameter, were inserted in the holes while the grout was still soft; those in the lower set of holes were to bind the upper and lower parts of the cracked footing together, while those in the top set were to tie or dowel the stone pier to the footing.

Cement gun remodeled

A cement gun was transformed into a pressure grouting machine as shown by Fig. 2. The regular outlet-valve body, with its rubber outlet valve and gooseneck, was removed and replaced with a delivery plate (Fig. 2). The outlet valve was then replaced with a 1½-in. gate valve *A* and a 1½-in. delivery pipe nipple *B* and the gooseneck was replaced with a ¾-in. pipe nipple *C* extending into the bottom hopper to within about ½ in. from the feed-spider.

The semi-fluid grout was forced out of the bottom hopper by air pressure introduced through the pipe nipple *C*. Thus the compressed air had to bubble up through the grout before it emerged into the space above the grout in the bottom hopper; this helped the rotating agitator *K* and feed-spider *L* to keep the grout agitated. The agitator fan *K* was made of sheet metal and it operated like a propeller submerged in the grout. The feed-spider was used merely as an auxiliary agitator and not as a feed control. This threefold agitation prevented the heavier particles of cement from settling to the bottom of the hopper where they would tend to plug the outlet delivery pipe. The charging screen *X*, at the top of the charging hopper, also proved to be an essential detail; it screened out lumps in the grout which otherwise would have plugged the delivery pipe nipple *B*.

Special pressure control

The need for positive control of grouting pressures prompted equipping the gun with the pressure gage *D*, which indicated the pressure of the main air supply from the portable compressor; the pressure-reducing valve *E*, which permitted the regulation of the air pressure on the delivery hopper; the pressure gage *F*, which indicated the pressure being used on the delivery hopper, and the pressure gage *G*, which indicated the pressure under which the grout was being delivered to the holes in the pier and its footing. Check valve *H*, in the delivery-hopper air-supply line, prevented any momentary backward flow of grout at times when the air pressure in the line was reduced below that carried in the delivery hopper.

This positive control of grouting pressures reduced any chance that high enough pressures might be

Fig. 1. Plant arrangement for grouting a damaged bridge pier foundation with a remodeled cement gun.

built up in cracks or voids within the pier footing to split it further or to move it. As a further check against building up dangerous internal pressures the operation of the cement gun proceeded as follows: The delivery hose was connected to the grout pipe of the first hole in the series and before any grout was put into the delivery hopper, the reducing valve *E* was set for 10 lb. per sq.in. and compressed air was admitted to the bottom hopper and fed to the hole to be grouted. Since the excavation around the pier had not been completely pumped out, it was possible to tell, by the escaping air bubbles in the water, just where the largest internal leakage was and also to identify the holes which were interconnected by cracks.

Cement grout, mixed in the ratio of 6 gal. of water to 1 bag, or 1 cu.ft. of cement was then transferred by buckets from the concrete buggies to the cement gun and after setting the reducing valve for about 35 lb. per sq.in. or more if necessary, the real grouting operations started. The top charging hopper was kept full and periodically dumped into the delivery hopper below without interrupting the flow of grout to its destination; this continuous feed constituted one of the chief advantages of the cement gun over the usual intermittent type of pressure grouting equipment.

The progress of the operation could be ascertained quite satisfactorily by watching the pressure differential between gages *F* and *G*; by the gradual disappearance of the telltale bubbles in the water around the pier and the issuance of small quantities of grout through the corresponding cracks; by the "feel" of the bell valve located between the two hoppers of the gun, and by measuring the depth of grout in the delivery hopper each time after the bottom hopper was filled. At the start, all caps on the adjacent grout pipes were removed until grout under pressure filled and overflowed a pipe, which would be immediately capped; if another pipe then filled, that one would also be capped. Meanwhile, grouting operations continued on the original pipe just as long as grout continued to flow, after which the gun would be moved to an empty pipe and operations repeated.

The drilling was done with a drifter drill mounted on a quarry bar. Drilling was stopped temporarily on each hole when the drill struck water, and the drifter was then changed over to wet type and drilling operations continued until the desired depth was reached. Dewatering the excavation around the pier was accomplished by a gasoline-engine-driven centrifugal pump, equipped with a self-primer that was designed and constructed by the local construction supervisor.

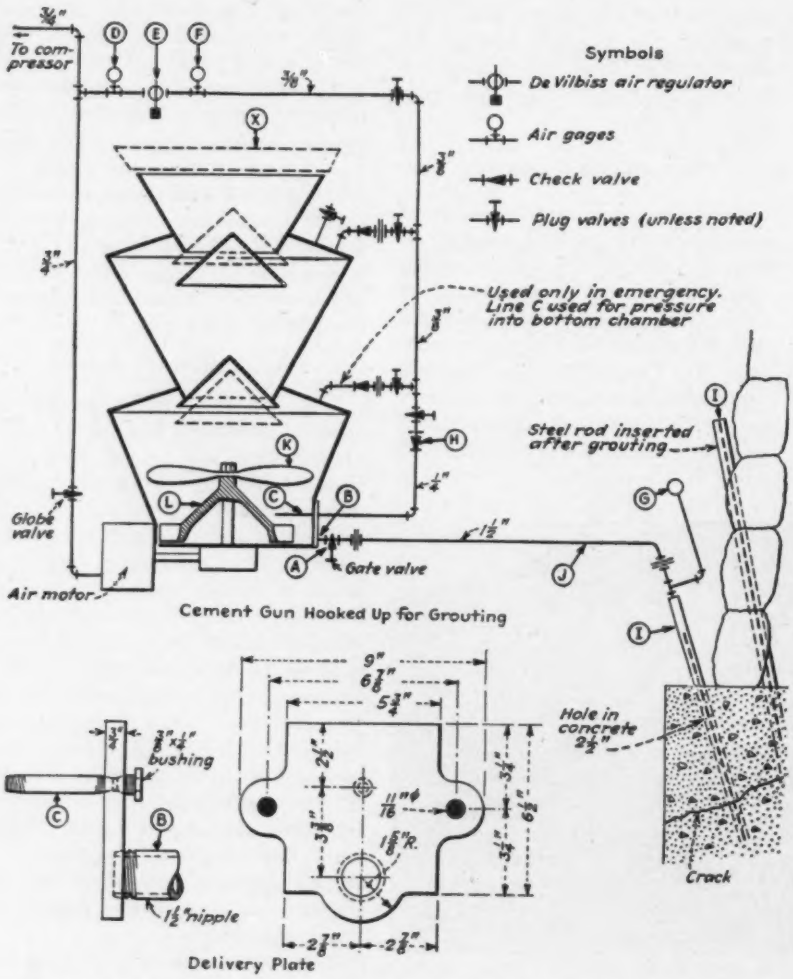

Fig. 2. Pipe line and valve arrangement for operating a cement gun as a pressure grouting machine.

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Annual Property Inventory For Municipalities

A yearly check of city-owned real estate and equipment, usually one of the largest assets of a local government, is recommended in a manual issued by the Municipal Finance Officers Association. Many municipalities are not aware of the value of their ownings, because the original expenditure was treated as an expense and no permanent record of the property has been set up. In some instances, the total investment in fixed assets is recorded, but detail records showing kind and pieces of property owned by the city are lacking.

The manual suggests a three-way division of the property check or inventory. Under personal property, the inventory would catalog machinery, equipment and office furniture. Under real property, land, buildings and other improvements such as pavements, sewers, sidewalks, gravel roads and water mains will be included. Real estate acquired through tax title proceedings would make up the third inventory. Information concerning the manual can be obtained by addressing the Association at 1313 East 60th St., Chicago.

Keeping the Public Posted

ROY L. PHILLIPS
City Engineer, Meadville, Pa.

Contents in Brief — This is the story of what one city official has been doing to keep his community informed on municipal works and services. In it are related experiences with the press, politician and the public.

A CHINESE PHILOSOPHER once said that "those who tell do not know and those who know do not tell." Where is the public works official who has not been a victim of the loose talker, or "curb stone engineer" whose vicious story is believed for lack of a better one? It is obvious that the only solution of this problem is to have the "telling" done by those who "do know."

Probably the best asset any public administrator can have is the support of an honest impartial press. In the writer's city, excellent relations with the press have been established by trying to make ourselves as helpful to them as we hope they will be to us. Placing confidence in reporters and editors by telling them the entire story, even when parts of it are not ready for release to the public, results in an intelligent presentation of the stories released. Confidences are seldom violated, but in any event, an occasional "leak" will not do your program the harm that may be done by an antagonistic, prowling reporter.

In Meadville we make a point of supplying articles explaining the various operations of the government. Having these appear on a certain day each week over a considerable period of time is good practice as it synchronizes with syndicated articles and seems to fit the reading habits of the people. In articles of this type it is desirable to present costs of operations so that they mean something tangible to the average man. This leads to relating costs of operation to the tax rate and has sometimes helped either to quiet the demand for increased service or win support for increased taxes to finance such service.

> One of a series of articles devoted to the proposition that upon the development of better public and employee relations rests the future welfare of the construction industry.

Recreational facilities on the grounds of the waterworks plant bring the public to a place where they are made acquainted with an essential utility service.

Recently a troublesome official, addicted to seeking publicity by unfair statement of half-truths, was quieted by giving the papers complete stories with all supporting facts and figures in advance of his efforts. These frank statements successfully "pulled the punches" of our friend. And a series of informative articles published a few years ago were so effective that disgruntled potential candidates for office protested against them on the grounds that they were creating too favorable an impression of the men holding office. This proved their potency.

Tell your story

The papers are not the only means of contact with the public. People in our city, as elsewhere, are "joiners" and we have many service and literary clubs, church groups and similar organizations. These groups are all potentially interested in information about their city and the way it works. The writer considers it part of his job to appear periodically before these groups and in many cases the public works story is told on the ground where an improvement is being made. For instance, the Rotary, Kiwanis and Lions Clubs were invited to visit the new sewage treatment plant during construction and after the plant had been placed in operation. In each case lectures were given, and invariably the result was the generation of an enthusiastic support for a project which previously seemed to the layman to be of doubtful local benefit.

Student nurses from local hospitals make an accompanied tour of the city-owned waterworks and the sewage treatment works, a requirement before they are graduated. High school science students are also taken through the city plants. This takes

time but it is a valuable investment. In addition to discussion of the plants visited, the general problems of the city are mentioned. Attention is called to the fact that no one should criticise any operation without getting first hand information as they are doing. This appeals to their sense of fair play, and we find that father and mother at home have been made more honest in their judgments.

Not to be overlooked is the fact that good public relations begin at home. One disgruntled or incompetent employee can annul months of work in winning good will. If men are hired or promoted for any reason other than their qualifications for their job, it is difficult to maintain the morale necessary to present a united front to the stockholders of your community. In Meadville men of all political faiths may be found on the city payrolls, and patronage, the enemy of good government, has never been a problem.

Some helpful ideas

Sometimes it is desirable to let the movement for an improvement originate outside City Hall. Parking meters, for instance, were sold to a merchants group by members of their own organization and installed on three-months trial. At the public hearing held at the end of the trial period only four people asked to be heard, and today the parking meter is very popular. Although ideas have frequently been suggested quietly to outside organizations, we do not believe in the public referendum. The writer firmly believes that problems of modern government are too complex for settlement by town meetings. A city official is elected to use his best judgment in making decisions rather than to make them with his ear to the ground—ground rumblings are a very unstable basis for sound judgment.

Outside contacts

Membership in local organizations such as Chamber of Commerce has been very helpful to the writer. A word of explanation at the right time frequently checks misguided criticism of public works services and objectives. Such attendance also has the advantages claimed by the woman who always arrived at Ladies Aid meetings early and stayed late so she would not be talked about in her absence.

Canal Lined with Cotton Fabric

Contents in Brief—Utilizing cotton fabric as a reinforcing agent for a gravel-asphalt mat, an experimental mile of leaking irrigation canal in Idaho was lined successfully. This article gives experiences gained in the construction procedure which is new.

COTTON WAS USED as reinforcing in an irrigation canal-lining experiment near Soda Springs, Idaho, in which asphalt and gravel were reinforced by the fabric. Started in 1937 the work of lining was completed last year prior to the 1938 irrigation season. The experiment, undertaken to cut the excessive leakage into the lava formation, has been successful in reducing it to less than 1 per cent from a former 8 to 11½ per cent. Water and winter disintegration has been nil; plant growths and gophers have been repelled.

The canal lined, 5,040 ft. in length, is composed of sections varying from 14 to 32 ft. in width. The first section was graded to a 14-ft. bottom width with 1 on 2 side slopes, 3-ft. banks and a gradient of 3.43 ft. to the mile. The slopes and bottom were wet down and rolled where practicable. Difficulty was had in rolling the slopes but the rolling finally was accomplished by attaching an oscillating roller to the side of a truck. A light penetrating oil, SC-1A, was sprayed on it at the rate of ⅝ gal. per sq.yd. to permit compacting the earth and give sub-base stability.

Next came the laying of the 80-in. strips of cotton fabric which had a mesh of ten $\frac{1}{16}$-in. strands to the inch. The fabric was laid in four courses longitudinally with a 4-in. lap. Experimentally, a light spray of 95 per cent asphaltic oil was applied before laying the fabric but for most of the work the fabric was laid without advance spraying but with ½ gal. of 95 per cent asphaltic oil sprayed on immediately after laying. Stone chips, ⅛ to ⅝ in. in size, were then spread on by shovel from a truck and evened up with wire brushes. A second coat of the same oil, ½ gal. to the sq.yd., was sprayed onto the gravel chips and 5 lb. to the sq.yd. of screenings added as a mop coat. Inclement weather impeded the spraying operation in 1937 putting over completion until the spring of 1938.

At the beginning of the work of laying the fabric, reinforcing strips of hoop steel with lugs punched every foot were laid longitudinally of the canal and secured with heavy wire staples. The spacing was such as to encounter the two outside edges of the fabric. After applying the fabric the lugs were rolled flat with a hand roller thus holding the fabric in place. Steel strips were placed under only a small portion of the work as the method proved slow and time was limited, the fabric merely being overlapped 4 in.

Experience gained with this job indicates certain points that should be observed, as follows: A properly compacted slightly full surface on the slopes should be cut to true line with a tilted blade machine to give a smooth surface for the light oil application. Settlement with water and heavy rolling might serve as an alternate. All banks and surfaces should be treated with sodium chlorate, 7 lb. to the square rod, to repel rodents and inhibit weed growth. The light oil, heated to 200 to 300 deg., should be sprayed on with a bar nozzle at least ½ gal. per sq.yd. and let penetrate for 2 days. Then a section the width of the fabric should receive ¾ gal. of 95 per cent asphaltic oil. In addition to the longitudinal hoop steel (20-gage, 1 in. wide punctured with ⅜-in. lugs bent at right angles to the steel) transverse steel cut 1 ft. longer than the width of the fabric should be laid every 8 ft. The fabric should be unrolled and fastened over the upright lugs and receive the oil and chips as noted above. The surface can then be travelled on and parallel strips laid, rolling down the lugs

on the longitudinal strips after adjacent strips of fabric have been lapped. The transverse strips should be cut long enough to lap at least 6 in. at the lower end and have a foot to bend down and insert at the upper edge of the bank. Steel strips may be omitted from the bottom but are advantageous on the slopes. The last ½ gal. of 95 per cent oil on the slopes should be sprayed on with a side bar nozzle and the bottom completed with a rear bar nozzle. The 5-lb. mop coat of screenings, ranging from sand to ½-in. chips with dust removed, should be well rolled.

No slopes steeper than 1 or 2 should be attempted on account of the danger of the whole mass slipping under high temperatures. However, a 200-ft. section through a rock cut was laid successfully on 1 or 1¼ slope and has held well through the past season.

Leakage in this canal was due to its being constructed through lava ash soil overlying fissure lava. The water would percolate to a fissure and gradually open a large whirlpool when not repaired. For years, in a 6-mile stretch with 100 to 200 sec.-ft. flows, 20 to 30 per cent loss had been sustained. Current meter measurements in 1937 on a section before and after lining and in 1938 after all work was completed showed the following results:

Date	Flow Sec.-ft.		Loss Sec.-ft.	Loss Per Cent
6–17–37	122.2		10.0	8.2 Before
6–26–37	111.2		12.8	11.5 Before
7–10–37	70.9		7.2	10.1 Before
11–29–37	21.0		0	0 After
6– 6–38	98.0	Gain	1.2	.... After
6–16–38	115.5		1.16	1.0 After
6–23–38	127.8		1.2	1.2 After
7–22–38	113.0		1.6	1.4 After
8– 1–38	76.0	Gain	0.7	.... After

The gains are due to fluctuations at the headgate where the flow is affected by a power plant fluctuation.

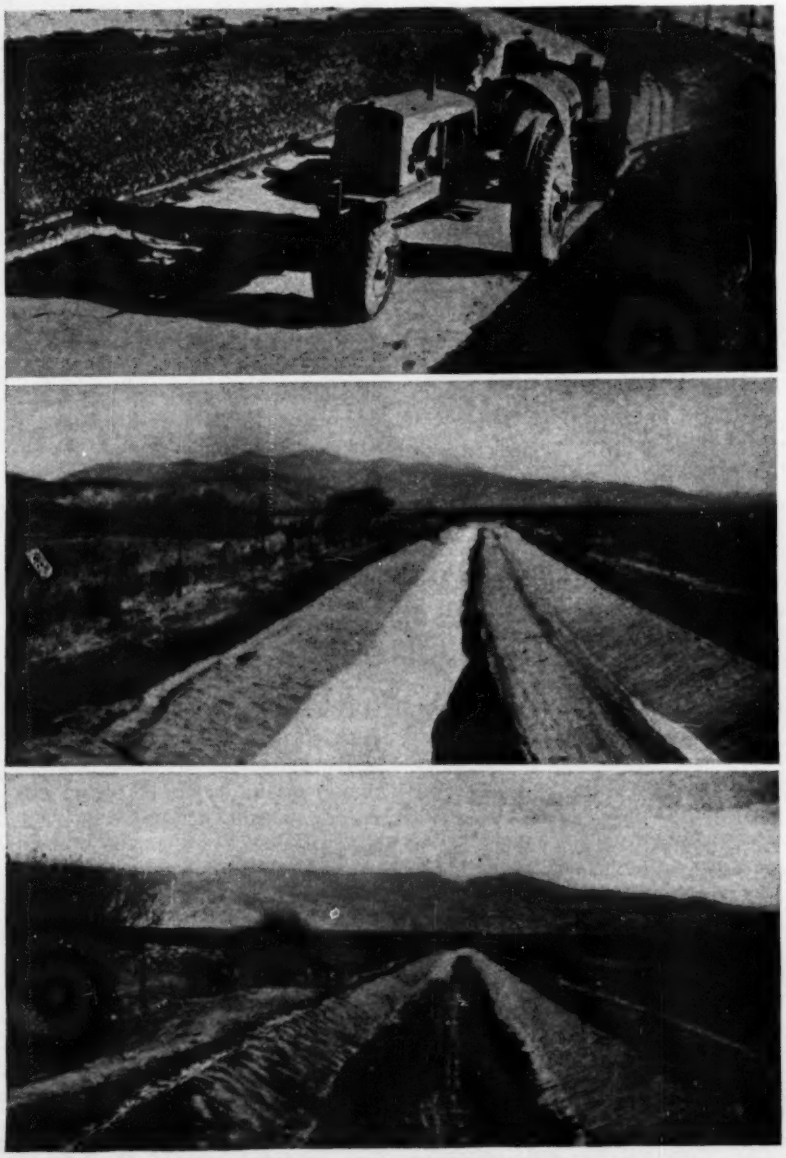
Actual measurements during 1938 showed that the coefficient of roughness was approximately 0.017 and that $n = 0.020$ would be a safe coefficient to use. Experience indicates that velocities up to 10 ft. per sec. may be passed safely.

Observations made at each date of measurement in 1938 indicated no disintegration due to the water flow. It was anticipated that there might be sloughing of the bank slopes above the water line due to extreme temperature but none was noted except for slight bleeding where the oil surface had not been properly covered with the mop coat.

The only moss growth noted was hair moss which clung to the side slopes near the water surface but it was too slight to affect the flow. Where treated with sodium chlorate the top banks were free from all vegetable growth and from gophers which formerly had been a nuisance. In the spring of 1938 no noticeable effect of frost was apparent in the partially finished section, due, it is thought, to the resiliency of the lining.

As closely as the engineers could figure, the cost of laying the lining should not exceed 70c per sq.yd., and may be as low as 50c. Representatives of the oil company that assisted in the work believe it should be possible to cut the cost to 40c per sq.yd.

E. J. Baird, civil engineer, Soda Springs, Idaho, promoted the experiment, obtaining the assistance and cooperation of the U. S. Department of Agriculture, which furnished the cotton fabric; the Utah Oil and Refining Co., which furnished the oils and expert assistance in spraying them, and the North Extension Canal Co., which did the preparatory grading and furnished the gravel and labor.



Spraying the side slope with side bar nozzle is shown at the top; below is a strip of fabric tacked on top of the oil coat; and the lower view shows the bottom of the canal covered with two strips of fabric after receiving the mop coat.

Highlights of the Waterworks Convention

Extracts from papers presented at the technical sessions of the American Water Works Association meeting in Atlantic City, June 11-15

PAPERS AND DISCUSSIONS prepared by more than 80 authors centered the attention of delegates to the 39th annual convention of the American Water Works Association on recent developments and better practice in the design, operation and management of waterworks facilities. Wide interest was evidenced in the announcement of a new law for the design of cast iron pipe based upon 13 years of research.

Occupying an important position in the technical session were three papers on water-hammer phenomena. These outlined simplified methods of calculation, the results of recent studies on a long pipeline, and methods of control by proper valve installation. Experiences presented in the application of cathodic protection for steel water tanks suggested possibilities for making such structures corrosion-resistant at low cost.

A new method of stabilizing water in softening or corrosion control by the addition of small quantities of sodium hexametaphosphate was featured as an advance in water purification technique. Known as "threshold treatment," it was said to have useful application in public water supply treatment based on experience with industrial water conditioning and some municipal plant trials.

The following extracts from some of the papers present in brief form highlights of the four-day technical meeting. The papers are arranged under three classifications: Design and Research, Purification and Plant Operation, and Plant Management. Details of the general sessions are reported in the news pages of this issue and the June 15 issue.

Design and Research

A new law of design for cast iron pipe has been developed by committee A-21 of the American Standards Association following 13 years of research and investigation. The law emphasizes the importance of external loading of the pipe line and the fact that external load conditions as well as internal pressure must be considered if safe, and at the same time economical design of wall thickness is to be obtained. A factor of safety of 2½ is used in calculating net wall thicknesses.

Allowances for truck traffic are made based on the load of two 5-ton trucks passing. Pressure additions are also made for water hammer whenever the wall thickness required for such water hammer exceeds the thickness required to resist the truck load. In general, for heights of cover of less than 5 ft., the truck load is the dominating influence; where the cover is 5 ft. or more the water-hammer effect dominates.

Among the outstanding facts revealed by tests and incorporated in the new law of design are the effects of the height of cover and the method of laying upon required pipe wall thickness. Pipe laid in a shaped bottom trench with tamped backfill is the most favorable trench condition while pipe laid on blocks with untamped backfill is the worst condition.

A booklet containing tables and graphs enabling quick determination of pipe wall thickness for various field conditions can be obtained by addressing the American Cast Iron Pipe Co., Birmingham, Ala.—W. D. MOORE, *President, American Cast Iron Pipe Co.*

Aging of reservoir water

The quality of water impounded in large reservoirs changes markedly in chemical and physical characteristics during storage. These changes are mostly beneficial but there are many harmful changes which take place following initial filling of the reservoir. As time passes on, nature gradually "irons out" these early defects. This natural process is called "aging," and the period of time involved varies with different characteristics such as topography of the drainage and flooded areas, the storage ratio, and reservoir depth and area.

For example, the apparent color of the Wanaque (N. J.) reservoir (Capacity, 100 mgd), the basin of which was cleared of trees to the ground level and where there was complete removal of trees for a distance of 5 ft. above and below normal flow line level, reached a minimum of color in a bottom sample seven years after filling. When the storage ratio is approximately 1.0 the practical period of color aging may be of seven years' duration.

From the standpoint of mineral salts, such as iron and manganese, in the bottom water, there is a vast improvement during the first three years. Manganese improvement apparently is slower than the iron improvement. Carbon dioxide in the Wanaque reservoir appears to have reached a stable minimum in the bottom water in the sixth year. The dissolved oxygen content of the bottom water was zero during the fall seasons of each of the first three years, after which it was always present.

Hydrogen sulphide was present during the fall and summer of the first three years in the bottom water, and extended upward through the transition zone to the surface. Following the first year there was no hydro-

gen sulphide at the surface. During the first year of filling, if this takes place during a growing season, a large reservoir may have excessive growth of chlorphyceae and cyanophyceae, and in succeeding years that reservoir may not again experience trouble from green or blue green algae conditions.—L. T. PURCELL, *sanitary engineer, North Jersey District Water Supply Commission, Newark, N. J.*

Water-hammer pressures

Considerable information relating to the calculation of water-hammer pressure has been accumulated during recent years but much of it is couched in mathematical terms of such nature that practical application of this information has not been extensive. This paper presented, in a simplified manner, the various methods available for making calculations and illustrated applications with typical examples encountered in waterworks practice. The elementary principles for graphical solution of water-hammer pressures was explained for both single and compound pipes. An analysis was given of the phenomena occurring in centrifugal-pump discharge lines and the effects of check valves, surge-suppressors and controlled valves. For solution of the complicated problem of water hammer in branching conduits an arithmetical instead of graphical method of calculation was described. A step-by-step method of the arithmetic solution for determining maximum water-hammer pressure in a line equipped with an air chamber was also developed.—F. M. DAWSON, *and* A. A. KALINSKI, *dean of engineering and research engineer, respectively, University of Iowa, Iowa City.*

Water hammer in long pipes

Water-hammer studies are being made by the Los Angeles Bureau of Water Works and Supply and the S. Morgan Smith Co. on a 20-mile pipe line equipped with gate and rotary cone valves varying in size from 12 to 24 in. The objectives of this work are to check water-hammer effects in large pipe lines against results obtained on smaller lines, and to apply these findings in the design and operation of valves. The investigation has not yet been completed but data thus far obtained indicate that the time in closing a valve can be saved without raising the water-hammer pressure by varying the speed of operation. Using an ideal line of velocity reduction to cause the least water hammer, coupled with data obtained from valve characterization, hypothetical curves for rate of operation have been developed.—LAURANCE E. GOIT, *engineer of distribution, Dept. of Water and Power, Los Angeles.*

Water-hammer control

Examination of data obtained in Los Angeles from studies on water hammer in long pipe lines shows that no valve of present day design embodies all the features necessary for perfect control. Since it has been found that fast rates of valve operation may easily be accomplished and are often desirable, the following factors become a pertinent part of valve design.

1. The characteristic of the valve with relation to per cent of area reduction versus time or strike.

2. Operating torque necessary to overcome the hydraulic unbalance plus the mechanical or sliding friction and the operating torque correlated with time.

From section characteristics of the various types of valves in common use it is shown that:

Gate valves utilize 80 per cent of stroke for 75 per cent of area reduction leaving 20 per cent of stroke for the final 25 per cent of area cut-off.

Globe or needle type valves cut off 75 per cent of area with 75 per cent of stroke, leaving 25 per cent of area to be cut off in 25 per cent of stroke.

Standard cone valves cut off 75 per cent of area in 52 per cent of stroke, leaving 25 per cent of area to be cut off in the remaining 48 per cent of stroke.

A cone valve with modified variation in plug movement was described in which the cut off curve is closer to the ideal. In this case, 75 per cent of the area is cut off in 37 per cent of stroke, leaving 63 per cent of the stroke for the last 25 per cent of area reduction.—E. C. BRISBANE, *chief engineer, S. Morgan Smith Co., York, Pa.*

Water and corrosion

Several of the theories and hypotheses advanced for the mechanism of corrosion tend to over-emphasize one or another single factor. Recent studies concerned with the chemical constituents and degree of corrosiveness of natural waters indicate, however, that primary, secondary and tertiary chemical factors play a role in the initial corrosion, and the rate and degree of corrosion. These involve the presence of oxygen, carbon dioxide, bicarbonate, sulfates and chlorides. Under certain conditions secondary factors, such as carbon dioxide and bicarbonate may be as important or more important than oxygen, which is the primary factor.

The chemical equilibria of dissolved salts and gases should be given important consideration in the study of corrosion phenomena. This is indicated by findings which show that natural waters with the same dissolved oxygen content increase in corrosiveness when the dissolved salt constituents increase.—WILLEM RUDOLFS *and* T. T. WONG, *chief and research assistant, Div. of Water and Sewage, N. J. Sewage Experiment Station, New Brunswick.*

Threshold treatment

Threshold treatment with sodium hexametaphosphate is based upon the discovery that a concentration of a molecularly dehydrated phosphate of the order of 1 ppm would effectively inhibit the formation of calcium carbonate scale when ammonia was added to irrigation waters. The descriptive name "threshold treatment" has been chosen to cover the general process of preventing deposition of calcium carbonate by this means because apparently the molecularly dehydrated phosphate acts to remove crystal muclei from contact with the solution on the threshold of the crystallization process. The name is equally appropriate with respect to the inhibition of corrosion.

Small concentrations of sodium hexametaphosphate (2 ppm or even less in some cases) added to hard water or partly softened water prevents further precipitation of calcium carbonate. Threshold treatment will slowly remove old scale as well as prevent the deposition of new material. The function of the hexametaphosphate appears to be to loosen the bonds between the individual crystals making up the scale, converting it to a sludge, this action being considerably accelerated at the higher temperatures. The rate of sludge removal is dependent on the water velocity.

Threshold treatment with a sufficient concentration of sodium hexametaphosphate definitely inhibits corrosion, while at the same time keeping metal surfaces free from scale. Laboratory tests on black iron pipe indicate that the inhibitory action upon corrosion is pronounced in its effect at both high and low pH values. OWEN RICE *and* G. B. HATCH, *engineer and chemist, respectively, Hall Laboratories, Pittsburgh.*

Purification and Plant Operation

In spite of outstanding progress in water purification during the last 40 years, outbreaks of waterborne intestinal disease have occurred. Outbreaks at Minneapolis and Milwaukee in recent years have been of particular interest because records of bacteriological examinations of the finished water indicated satisfactory sanitary quality according to generally accepted standards. As a result, questions have been raised which involve our fundamental conceptions of water purification.

A committee of the American Waterworks Association has been studying these outbreaks, and has concluded that the data available do not indicate any inherent weakness in methods of operation and control of purification plants, nor in present standards of water quality. Where epidemics have occurred the fault seems to be in failure to fully apply available purification methods and laboratory control particularly with regard to frequency and completeness of bacteriological examinations.

Recent recommendations of the state health departments in Minnesota and Wisconsin indicate a tendency toward more stringent quality standards for treated water. Among other things, the Wisconsin authorities recommended that 100 c.c. portions of water be examined for coliform organisms in lieu of the U. S. Treasury department standard of five 10-c.c. portions.—GEORGE D. NORCOM, *consulting engineer, New York City.*

Waterborne gastroenteritis

General pollution of potable water supplies with decomposing organic matter and miscellaneous bacteria of sewage origin is much more common than the occurrence of waterborne diarrheal diseases, indicating that a specific causitive agent is present temporarily in supplies transmitting such diseases. While complete information is lacking, the available data disclose waterborne gastroenteritis to be a bacterial infection resulting from consumption of water contaminated by organisms of the dysentery group or similar pathogens, while specific bacterial pollution is accompanied by coliform organisms.

Data from New York state do not support the view that such outbreaks may be due at times to the growth and decay of algae, nor to the products formed by the typical decomposition of organic matter. Isolated outbreaks may be due to some unknown but specific modification of organic matter in seriously polluted water, whereby substances irritating to the gastrointestinal tract are formed. One must rule out toxic industrial wastes and other direct chemical polution before a definite conclusion can be reached as to such outbreaks. —C. R. COX, *chief, Bur. of Water Supply, State Dept. of Health, Albany, N. Y.*

Water pre-treatment

Chemicals added to water to induce flocculation and aid in the removal of impurities prior to filtration should be thoroughly and rapidly mixed with the water before coagulation takes place. Quick or flash mixing prevents excessive reaction on a portion of the water while the balance remains underdosed. After flash mixing the next step is to provide a period of slow stirring to obtain collision and adhesion of the particles. The time required to obtain the best results from this slow mixing or flocculation step depends in large measure on the amount of coagulant and the temperature, rather than on the turbidity of the water.

Time of flocculation may be shortened at the sacrifice of low chemical cost. This is not economical, since additional mixing basin capacity is much cheaper than high consumption of chemicals. While the relation between chemical dosage and mixing time has not been definitely established, there are indications that on waters requiring low chemical dosage a doubling of the dosage will cut the time in half.

The method in common use to accomplish proper flocculation is to subject the chemically-treated water to gentle agitation by means of a horizontally-mounted shaft mechanism to which paddles are attached. The paddles are rotated at a speed of 0.6 to 1.8 ft. per second depending on the character of the water and the coagulant used.

The tendency today is to design settling basins with much shorter periods of detention than was the practice 25 years ago before the advent of mechanical mixing. Shorter detention periods are possible because of better preparation of the floc for settling. It is now common practice to provide 2-hr. detention in the settling basin when continuous sludge removal equipment is used, and 4 hr. without such equipment.—FRANK BACHMANN, *The Dorr Co., Inc., New York City.*

Cathodic protection of tanks

Cathodic protection for elimination of corrosion is not a new idea, but its application for the preservation of steel water tanks is a recent development. Galvanic action, a common occurrence when two dissimilar metals are placed in solution may also occur in a steel structure which is distorted under stress. Strained steel which is in electrical contact with unstrained metal usually becomes anodic or positive, and localized corrosion takes place when the couple is completed by water immersion.

If an opposing current of sufficient magnitude to overbalance the currents generated by the numerous small couples can be made to flow to the steel plates of the tank, they will become cathodic or negative to the ground and corrosion stops. Metallic ions from the anode will go into solution and hydrogen ions will be released to form a protective film on the tank plates.

In practice, a power source, generally a rectifier connected to a light circuit, furnishes direct current at low voltage. The positive terminal is connected to a metal rod hung from the roof of the tank and insulated therefrom. The rod is immersed in the water at all times. The tank and the negative terminal of the power source are either grounded or con-

nected. Current passes from the anode through the water to the tank plates. Iron ions pass into solution setting free hydrogen ions which are plated on the tank surface. The tank surface becomes plated with mineral ions present in the water and set free by iron ions going into solution, forming a grayish film which gives added protection to the tank plates.

Two tanks in Dayton have been equipped with cathodic protection with the result that rusting and corrosion have been eliminated.—W. W. MOREHOUSE, *Director, Department of Water, Dayton, Ohio.*

Service line materials

A review of the experience of the past half-century leads to the following generalizations with respect to service pipe materials:

There is now no uniformly satisfactory material in common use; material satisfactory with one kind of water may be far from satisfactory with other kinds.

For hard waters, low in carbon dioxide, lead, galvanized iron and steel and copper are reasonably satisfactory.

For soft surface waters, copper is probably the best of the materials now available. For soft groundwaters, high in carbon dioxide, cement-lined iron appears to give on the whole the best results.

Lead should not be used with waters high in carbon dioxide.

The World of Tomorrow must develop a new kind of material for service pipe. Development in the field of plastics and synthetic resins indicates that in this direction may lie the answer to the superintendent's prayer for the perfect service pipe. At present there are some materials such as Lucite, which appears to possess some characteristics not far different from those sought for in service pipes.—E. SHERMAN CHASE, *consulting engineer with Metcalf & Eddy, Boston.*

Superchlorination practice

The superchlorination process (application of such large doses of chlorine as to require subsequent use of a dechlorinating agent) has been demonstrated to be an effective means of taste and odor control at a number of water treatment plants. The doses of chlorine required for this purpose are not excessive when compared with the cost of other methods used for the same purpose; the dosage ranges from 1.0 to 7 ppm for the removal of tastes produced by algae, phenols and vegetation.

Sulphur dioxide and granular activated carbon have proven to be economical dechlorinating agents. Both methods are applicable to plants of any size and may be made practically automatic in operation. A secondary advantage of using superchlorination is the high degree of bactericidal efficiency of such a process.—HARRY A. FABER, *research chemist, The Chlorine Institute, Inc., New York City.*

Plant Management

From an analysis of the wholesale cost of water (cost of the system up to the point where bulk transmission ends and distribution begins), based on a study of costs in major cities of this country it was revealed that the average is $70 per million gallons. Wholesale operating costs vary, but show a general average between $20 and $25 per million gallons; this cost is largely dependent on type of supply and is usually lowest in the case of large gravity supplies from impounding reservoirs. Total costs average about $115 per million gallons.

In the light of present construction costs, it seems inevitable that an upward revision of wholesale value of water per million gallons is in order. Tentatively this may be set at $80 to $100 and will unquestionably go higher in some instances. A small community that sinks a well near the center of distribution can occasionally produce water at a lower figure. The author states that he knows of more than one case where recent local supplies have cost over $100 per million gallons.—CHARLES H. CAPEN, *engineer, North Jersey District Water Supply Commission, Newark, N. J.*

Charges for fire protection

Before private fire protection can be provided by a municipal waterworks large sums of money must be expended in providing elaborate supply and distribution facilities. Part of the cost of this plant must be allocated to fire protection purposes, but it is difficult to establish uniform schedules of charges because waterworks costs vary over a wide range. In Denver it is estimated that the cost of the plant required for fire protection is about 15 per cent of the total investment, and the cost of operation chargeable to this service is 2 per cent of the total. In smaller cities the percentage will be much higher, and in larger places the costs might decrease.—D. D. GROSS, *chief engineer, Board of Water Commissioners, Denver.*

Discussion—As a general rule, the excess cost of a water system in large cities for fire protection does not amount to much above what the ordinary requirements would be to meet peak domestic service, according to J. B. Winder, Superintendent of Water Works, Dallas, Texas.

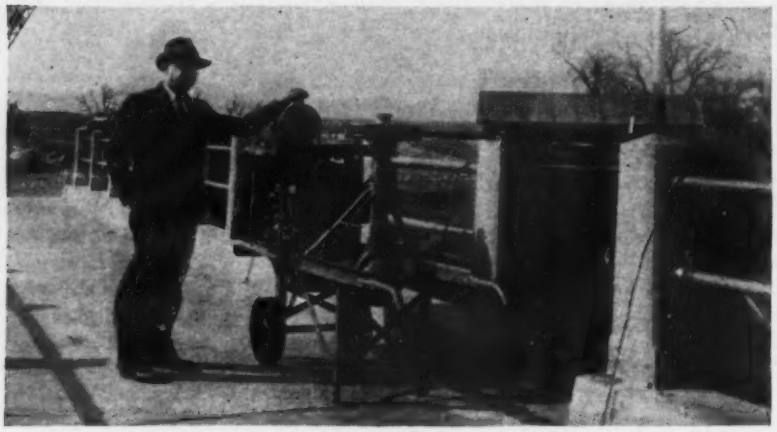
Service life of pipe

There has been no factual study of importance which has determined from actual long-time records the service life of mains in water service. The reason for this is that rarely are records available of main installations and retirements covering any duration of time. In Springfield, Mass., records have been kept for 75 years and these formed the basis for a partial study of service life. Mortality survivor curves, projected from the data available, indicate the average life of 6-in. pipe will be somewhere in the neighborhood of 140 to 150 years, and for the 8-in. size the period would be 160 to 170 years. The curve for 10 in. and larger pipe shows a still greater average life.

In view of the common use of linings for pipes to carry corrosive waters and the progress that is being made in the treatment of water to resist corrosion, it appears reasonable to conclude that in the future the service life of cast iron pipe will universally tend to approach that resulting from necessary replacements due to changes in demand conditions. Experience in Springfield, where such changes have been as numerous as can reasonably be expected because of the things that have happened in the development of that system, indicates that our ideas of service life of cast-iron pipe are due for revision upward.—REEVES NEWSOM AND E. H. ALDRICH, *consulting engineers, New York City.*

FROM FIELD AND OFFICE

Working problems and time-saving methods . . . Edited by Charles S. Hill



Power drive for hand wheels on intake gates made from old automobile engine.

Old Automobile Engine Operates Gate Winches

Finding the hand winches on the intake gate at the Loup River Diversion dam hard to operate and slow, engineers of the Loup River Public Power District at Columbus, Neb., devised the portable power drive shown in the accompanying photograph. An old automobile engine was mounted on a truck frame of such height as to bring the pulley wheel that had been substituted for one of the auto wheels on a level with the hand wheel on the gate. A second pulley wheel clamped to the gate shaft above the hand wheel makes it possible to turn the gate shaft with a rope drive from the engine.

The "gyro" as it is called can be wheeled from gate to gate and adjusted quickly. The whole rig cost only about $45. Fred C. Albert, chief civil engineer for the district, stands by the gyro.

• • •

Safe Bulge In Walls

C. B. DANNENBERG
Assistant Building Inspector
Wilmington, Del.

The following derivation of a simple formula to determine the maximum permissible bending in a wall is presented as a practical rule for definite decision whether a wall has sufficient bulge to warrant the building inspector to order the wall to be rebuilt.

$$\text{Tan } a = \frac{\frac{2E}{H}}{2} = \frac{4E}{H}$$

$$\text{Shear } S = W \text{ Tan } a = \frac{4EW}{H}$$

$$\text{Bending moment } M = \frac{SH}{4}$$

$$= \frac{4EWH}{4H} = EW$$

Section modulus of wall $= \frac{BT^2}{6}$, in which B is a unit of length of wall, and T is the thickness.

$$\text{Unit compressive stress} = \frac{W}{BT}$$

$$\text{Unit bending stress} = \frac{\frac{EW}{BT^2}}{6} = \pm\frac{6EW}{BT^2}$$

When the tensile stress due to bending is equal to the compressive stress due to direct load,

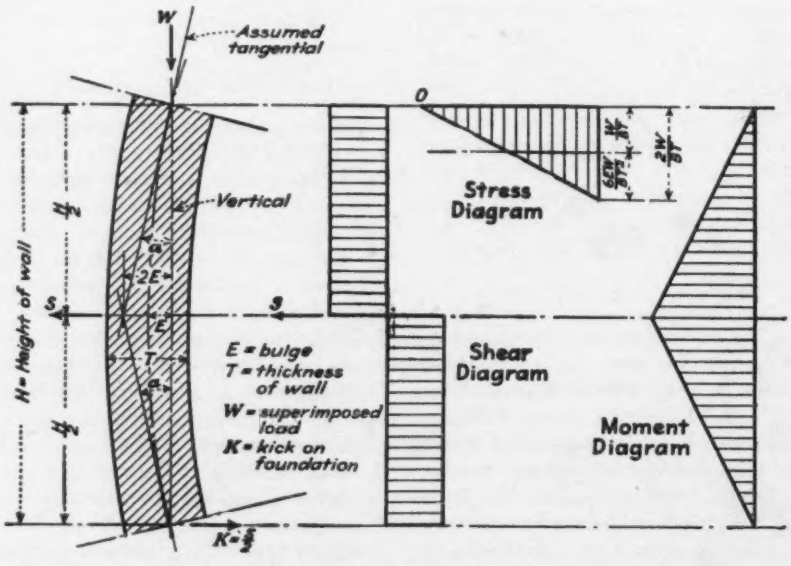
$$\text{then } \frac{6EW}{BT^2} = \frac{W}{BT}$$

$$\text{and } E = \frac{WBT^2}{6WBT} = \frac{T}{6}$$

Therefore the amount of bulge in a wall should not exceed one-sixth of its thickness. At this limit the tensile stress induced by bending is equal to the compressive stress induced by the direct load, and the total compressive stress is equal to $\frac{2W}{BT}$.

When the bulge exceeds $\frac{T}{6}$, the moment stress will be in excess of the compressive stress, tension will be induced in the bed joints which will open up to the weather when the bond is broken, the effective thickness of the wall will be reduced and ultimate collapse will sooner or later occur.

The many causes of bulged walls is another story but regardless of what causes the bulge, the safe procedure for the building inspector is to condemn a wall if the bulge is greater than one-sixth of its thickness. Though the defects may not be apparent, such a wall is inherently unsound.

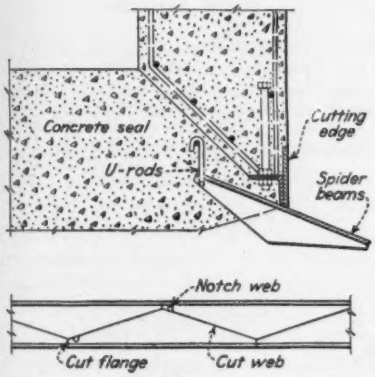


Method of determining significance of bulge in a wall.

Spider Beams for Caissons

R. L. LARSON
Bureau of Public Works,
Manila, P. I.

Spider beams, as shown by the accompanying sketch, driven out under the edges of caissons, were used by the writer for the four caissons of the Lungkaiho Bridge at Kiukiang, Central China, in 1927, and for the few caissons sunk of the 25 caissons proposed for the Sainam



Spider beams reduce depth of caisson sinking.

Bridges at Canton, South China, during 1933–1938. In both bridges hard clay strata were found to slope considerably or drop off abruptly within the caisson perimeters, so that the spider beams used to increase foundation areas in the softer strata overlying hard clay proved cheaper than the alternative of sinking the caissons deeper, for which superimposed loads on the caissons would have been necessary because of skin friction.

For the first bridge, open excavation was possible in the caissons but for the second, compressed air was necessary in most caissons, the economy of the spider beams being thus more marked there.

The spider beams were cut as indicated from second hand I-beams and short lengths of H-beams left over from the steel bearing piles driven for the new Canton Municipal Power Station completed in 1938. Hacksawing the flanges and hand-cutting the webs proved cheaper than oxyacetylene burning, but welding was used to connect the compression flanges of the two end half-sections from each beam, with riveted web splice plates, to make up an additional spider beam.

Vertical Curve Made Easy

LOUIS C. GAMBONE
Chief Engineer, Universal Constructors
Norristown, Pa.

The method most in use for solving a vertical curve is to find the correction distance for the middle ordinate by the formula:

$$M_o = \frac{LG}{800}$$

and to substitute this value in the formula

$$Y_x = \frac{M_o X^2}{(L/2)^2}$$

thus finding the correction distance for any point between the P.C. and the P.I. This procedure entails considerable arithmetical labor which can be materially reduced by finding a constant K while the distance X, varies between the P.C. and the P.I.

The constant can be computed thus:

$$K = \frac{G}{200\,L}$$

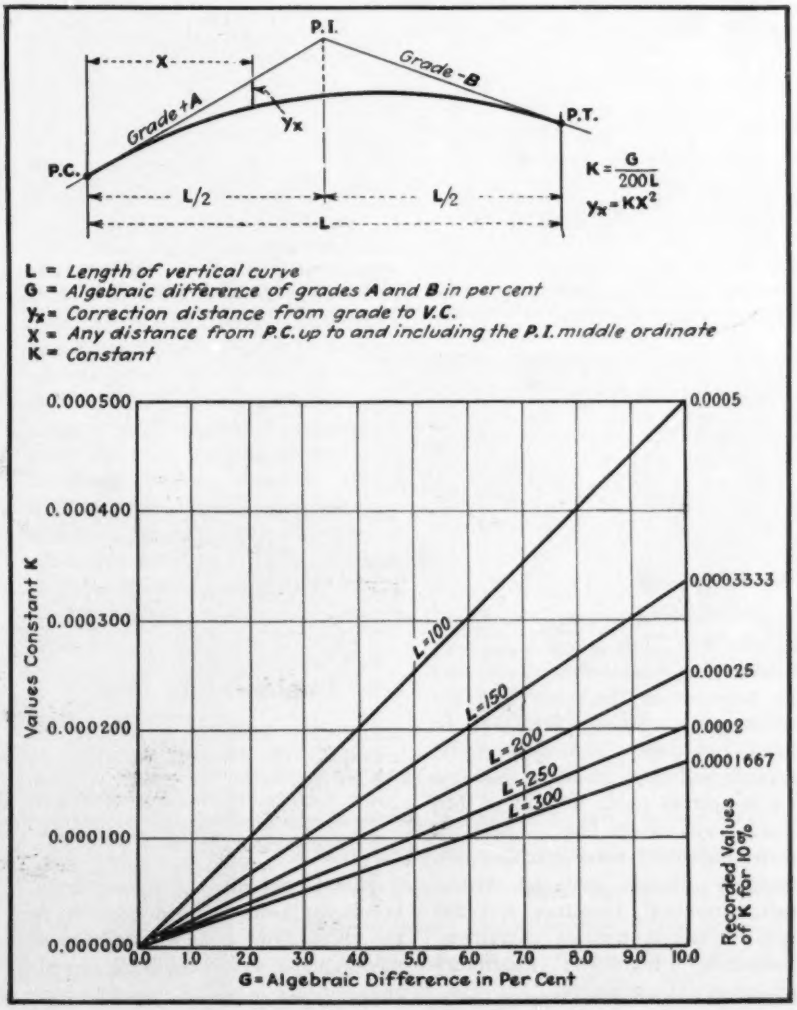
and by substituting K, for

$$\frac{M_o}{(L/2)^2}$$

we get $Y_x = K X^2$, for any distance from the P.C. up to and including the P.I.

This eliminates the necessity of squaring $(L/2)$ and dividing $M_o X^2$ by $(L/2)^2$. Seven decimal places to the right of the decimal point will give the most extreme degree of practical accuracy.

The graph gives values of K, for vertical curves where L is 100, 150, 200, 250 and 300 ft., and where the algebraic difference is up to 10 per cent. At the right-hand end of the graph the values of K for 10 per cent have been recorded so that if it should be desired to find the exact reading of K for algebraic differences, less or greater than 10 per cent for the length of vertical curve, it can be obtained by proportion when the graph reading is not desirable.



BOOK NOTES AND REVIEWS

The month's additions to the engineer's reading and reference list

City Planning Principles

CITY PLANNING—WHY AND HOW—By Harold MacLean Lewis. 257 pp. Published by Longmans, Green and Co., New York. Price $2.50.

Proving again that no subject is dull if properly presented, Harold M. Lewis tells the story of city planning in a manner that is both entertaining and educational. An expert himself (he is chief engineer of the New York Regional Plan Association and consultant for other municipalities), he nevertheless retains the common touch in describing the intricacies of planning so that others may see and understand how the planner works and to what ends.

The book is arranged in two parts, the first dealing with the "whys" of city planning, and the second part concerning itself with the "hows." This latter section is particularly useful for it presents an outline of the steps to be taken by the general public, the officials and the planning staff in preparing a practical city plan. Illustrated with maps and diagrams, this volume gives clear exposition to planning problems and suggestions leading to their solution.

Welding Contest Papers

ARC WELDING IN DESIGN, MANUFACTURE AND CONSTRUCTION—Published by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. 1,408 pp. Price $1.50 in U.S.; $2 elsewhere.

Early in 1937 the Lincoln Electric Co. of Cleveland created in honor of its president "The James F. Lincoln Arc Welding Foundation" to encourage progress in the science of arc welding by offering $200,000 in prizes for papers reflecting study, research and application in this new and important field. A total of 446 awards was made for papers in eleven industrial classifications—automotive, aircraft, railroad, watercraft, structural, furniture and fixtures, commercial welding, containers, "welderies," functional machinery and industrial machinery.

In this 1,400-page book, 129 of those prize papers are published, most of them in full. The selection of papers was made to afford the widest possible variety of subject matter. The structural field is represented, for example, by 14 papers, covering 220 pages. Buildings, bridges, tainter gates and dams are covered. Drawings and photographs are reproduced extensively, and the book represents a valuable addition to welding literature.

Concrete Bridge Design

REINFORCED CONCRETE BRIDGES—By F. W. Taylor, S. E. Thompson, Edward Smulski. 456 pp. Published by John Wiley & Sons, New York; Chapman & Hall, London. Price, $6.50.

This is strictly a design book, as distinct from a college text, although it follows the common text practice of giving a numerical example at the end of each chapter. In addition, each chapter on a certain type of concrete bridge includes brief descriptions of actual bridges, about half from European practice. For indeterminate structures such as continuous girders and rigid frames, the fixed point method of determining moments and shears is adhered to. These are the book's distinguishing characteristics. Its scope is broad, covering, chapter by chapter, bridges of slab, deck girder, through girder, cantilever, continuous girder, flat slab and rigid frame types. Although the treatment is specifically for reinforced concrete, much of the design information is applicable to a bridge of any material.

Engineers in War

AMERICAN ARMIES AND BATTLEFIELDS IN EUROPE—Prepared by American Battle Monuments Commission. Published by the Superintendent of Documents, Government Printing Office, Washington, D. C. 547 pp. Price $2.75.

This is not an engineering book, but as engineers had a major part in the preparation and reproduction of its fine maps, and as the book records engagements in which engineer regiments had a part, it seems to deserve notice in these pages. The present work is the outgrowth of a plan to replace an earlier publication of the Battle Monuments Commission that was out of print almost as soon as it was published. The new book is more comprehensive than that book, being in fact a brief history of the work of the American army in France during the World War. It is profusely illustrated with photographs and maps.

Piping Guide

PIPING HANDBOOK—By J. H. Walker and Sabin Crocker. Third Edition. Published by McGraw-Hill Book Co., New York and London. 897 pp. Price $6.

This third edition of a handbook first published in 1930 takes into account significant changes in piping practice which have taken place in the last eight years. The book is devoted exclusively to piping systems in power plants, distributing systems and in industrial operations. The revised edition includes among other things new information on welded joints, fittings and valves, on metallurgy of piping materials and on heat insulation. Dimensional standards and materials specifications also have been brought up to date.

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

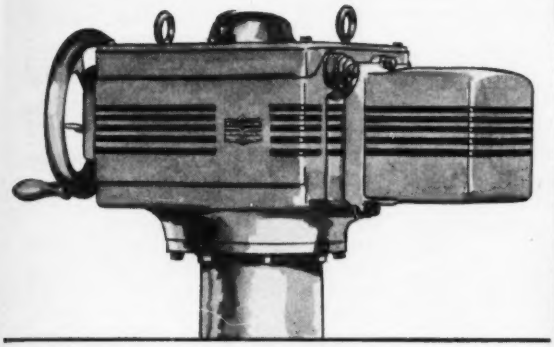
THE PRELIMINARY RESULTS of the Maryland state-wide highway planning survey have been published in pamphlet form by the Maryland State Roads Commission, Baltimore.

HYDRAULIC STUDIES carried on by Russian engineers are currently reported by the Institute of Hydrology, Academy of Sciences of the Ukrainian S.S.R. at Kyiv. Each paper is accompanied by a summary printed in English.

PUBLIC ASSISTANCE in New York City is the subject of a large pamphlet prepared by the Advisory Council, Works Progress Administration, City of New York. The report is the result of a study begun in May 1938 under the direction of the Advisory Council, which was made up of a group of prominent men from the in-

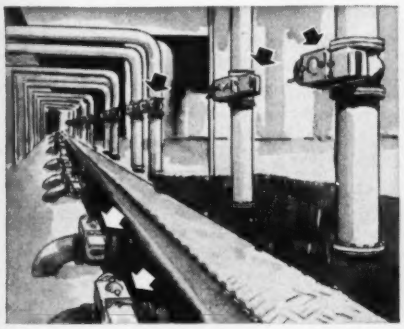
(*Continued on p. 74*)

ELECTRIC VALVE CONTROL SAVES LIVES, TIME AND MONEY

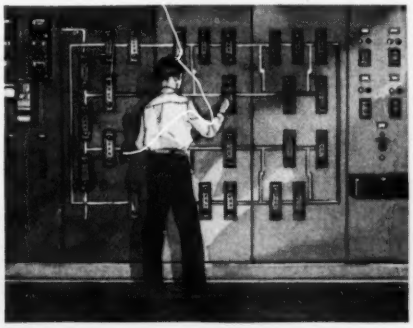


PUSH A BUTTON to open or close valves equipped with Cutler-Hammer Electric Valve Control. No running back and forth, climbing ladders, shouting of orders. Control station located wherever most convenient, or control may be automatic.

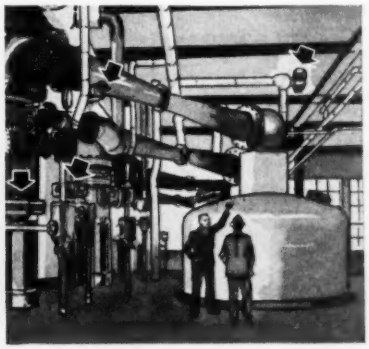
BACK SAVER. Closing large valves manually, is hard, time-wasting work. Valves only ½ the size shown here, when opened or closed by hand, require 15 minutes' hard work by 2 men for either operation. C-H Valve Control, 90 seconds at the touch of a button.



LIFE SAVER. Ability to close valves from remote point is great safety aid in handling high pressure steam, gasoline or inflammable gases where break in line might prevent men reaching valves.



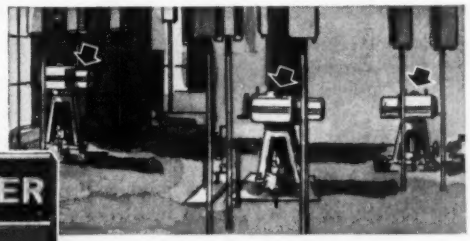
TIME SAVER. Valves may be located miles from control station, as is frequently done in city water or gas systems with C-H Control. Entire city supply controllable by districts at one central location. Invaluable in case of emergency.



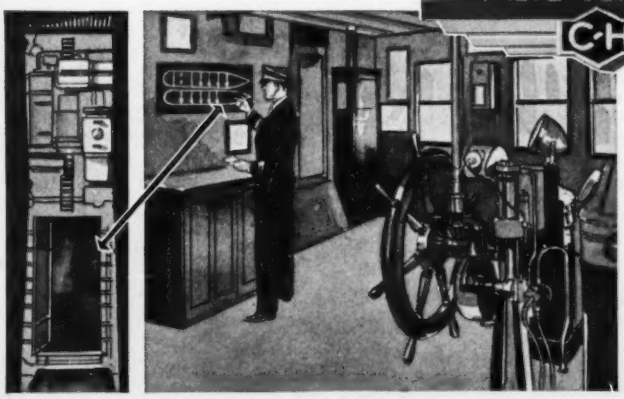
MONEY SAVER. Chemical and food products plants use C-H Valve Control, often for automatic operation by connection with timing devices, float or pressure switches, etc. C-H Valve Control can handle *anything* that flows.

Experts insist on—

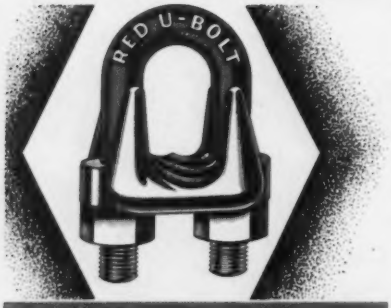
CUTLER-HAMMER
VALVE CONTROL
C-H



RED HOT JOB. Modern power plants operate with superheated steam at 900° F and pressures as high as 2000 lbs. Pipes and valve parts actually glow at red heat. Jamming red hot valve parts is avoided by C-H Valve Control.



ONLY A FEW of the many uses for C-H Valve Control are here described. As shown at the left, it is used for closing bulkhead doors from the captain's bridge—to guard lives at sea in case of collisions. You may find C-H Valve Control the answer to *your* problem. Write for information. CUTLER-HAMMER, Inc., *Pioneer Electrical Manufacturers,* 1261 St. Paul Avenue, Milwaukee, Wisconsin.



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CROSBY CLIP

Has been the standard of safety for wire rope fastenings since 1883—It is designed for greatest grip and drop forged from special analysis steel. Hot galvanized. Easy to put on; readily inspected. Cheapest because safest.

There is a dealer near you with all sizes in stock. Ask us for his name and address.

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CHICAGO SAINT PAUL, MINN. NEW YORK
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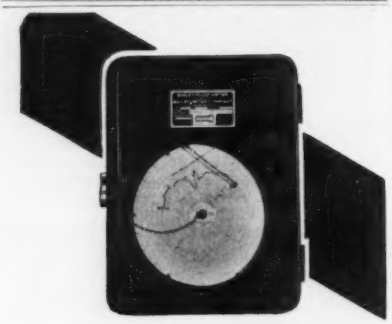

BAILEY
Fluid Meters
For STEAM · LIQUIDS · GASES

● Bailey Fluid Meters are designed to indicate, record and integrate the flow of steam, liquids, or gases under practically any pressure or temperature condition.

A great variety of indicating, recording and integrating combinations are available for use with four distinct types of flow mechanisms.

This large variety of possible combinations enables the flow meter engineer to specify equipment which is pre-eminently suited to any flow measuring application.

When it is desired to place indicators, recorders and integrators at a considerable distance from the primary element, Bailey Synchro-Meters are available to provide electric transmission.

For detailed information consult Sweet's Engineering Catalogs or request a copy of bulletin No. 301.

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Bailey Meter Company Ltd., Montreal, Canada

MISCELLANEOUS NOTES ON BOOKLETS AND REPRINTS

(*Continued from p. 72*)

dustrial and commercial organizations of the city. Included is a set of recommendations by the council as to how public assistance should be carried forward in the future. A limited number of copies are available to interested parties from the U. S. Works Progress Administration, 70 Columbus Ave., New York City.

PARKING PROBLEMS in business districts are covered in a 30-p. booklet published by Public Administration Service, Chicago. Price, $1. The booklet covers data on city-owned parking lots in 33 municipalities and on privately-owned off-street parking in 72 cities. Desirable elements of parking practice as developed in 147 cities are noted.

THE ARMY ENGINEERS have begun the publication of multigraphed reports of work on rivers and harbors carried out under their direction. Recent ones are: "Flood Control. Winooski River, Vermont"; "Flood Protection Project, Ironton, Ohio"; "Calumet Harbor and River, Illinois and Indiana"; "New Haven Harbor, Connecticut"; and "Johnstown Channel Improvement, Second Unit"; The Harbor of New York.

NEW ENGINEERING BOOKS

PUBLIC WORKS ENGINEERS' YEARBOOK 1939—457 pp. Published by the American Public Works Association, Chicago. Price $3.50.

HANDBOOK OF HYDRAULICS—By Horace Williams King. 617 pp. Published by McGraw-Hill Book Co., New York and London. Price $4.

THEORETICAL AND APPLIED CHEMISTRY—By Maurice de Kay Thompson. Third Edition. 535 pp. Published by the Macmillan Co., New York. Price $5.

ARCHITECTURE OF THE EARTH—By Reginald Aldworth Daly. 211 pp. Published by D. Appleton-Century Co., New York. Price $3.

ENGINEERING TERMINOLOGY — By Victor J. Brown and Delmar G. Runner. Second Edition. 439 pp. Published by Gillette Publishing Co., Chicago. Price $4.

TASCHENBUCH DER STADTENTWASSERUNG (8th Auflage)—By K. Imhoff. 252 pp. Published by Druck und Verlag von R. Oldenburg, Munchen und Berlin. Price 6.50 RM.

PIPE CORROSION AND COATINGS—By Erick Larsen. 455 pp. Published by American Gas Journal, Inc., New York. Price $2.50

METALLURGY FOR ENGINEERS—By E. C. Rollason. 272 pp. Published by Edward Arnold & Co., London; Longmans Green & Co., New York. Price $3.

PROBLEMS IN MECHANICS—By G. B. Karelitz, J. Ormondroyd and J. M. Gerrelts. 271 pp. Published by The Macmillan Co., New York. Price $2.50.

HOW TO MAKE GOOD CONCRETE—By H. N. Walsh. 103 pp. Published by Concrete Publications, Ltd., Westminster, England. Price, 4s. 6d.

THE THEORY AND PRACTICE OF REINFORCED CONCRETE—By Clarence W. Dunham. 529 pp. Published by McGraw-Hill Book Co., New York and London. Price $4.50.

REPORTS AND PAMPHLETS

A TRAFFIC SURVEY—Vol. I, Summary of Scope and Methods, also Appendix. May be obtained from the Chicago Park District, Traffic Engineering Section, Chicago.

LUMBER INDUSTRY FACTS 1939—Published by National Lumber Manufacturers Association, Washington, D. C.

NATIONAL IRRIGATION POLICY—ITS DEVELOPMENT AND SIGNIFICANCE—Senate Document No. 36—Correspondence and papers exchanged between The Bureau of Reclamation and Senator Carl Hayden.

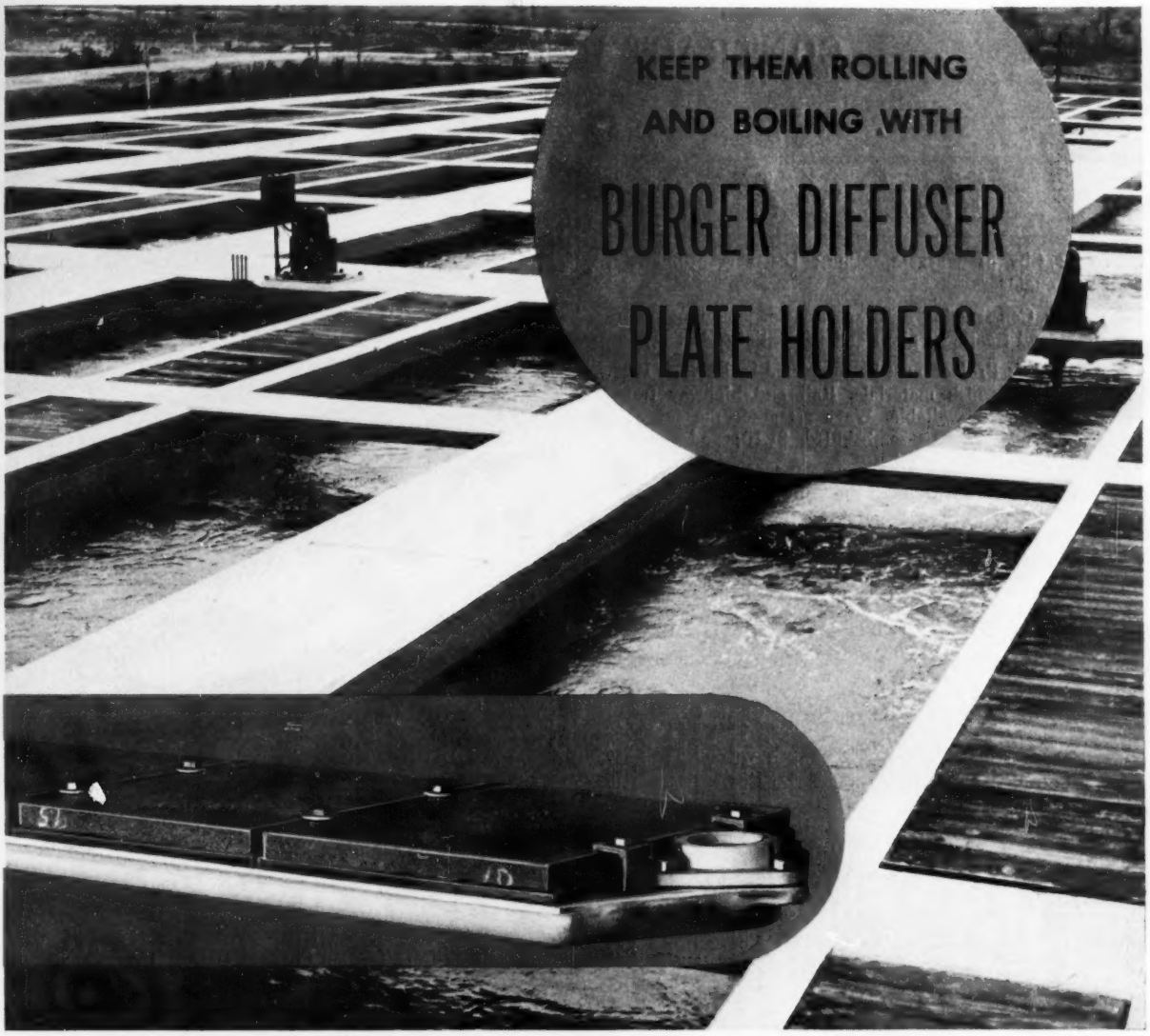
THE GREASE INTERCEPTOR—Bulletin of the University of Wisconsin, Engineering Experiment Station, Madison.

THE BENDING STRESSES IN THE MEMBERS OF A TRUSS DUE TO THE RIGID CONNECTIONS AT THE JOINTS—By I. A. El Demirdash. Published by A. G. Gebr. Leemann & Co., Zurich.

A BRIEF OUTLINE OF THE MAGNITUDE AND CHARACTER OF THE IRON AND STEEL INDUSTRY IN THE UNITED STATES—Arthur G. McKee & Co., Cleveland, O.

BONNEVILLE—First Annual Report of the Administrator.

THE VALUE OF HISTORY IN ENGINEERING EDUCATION—Bulletin of Rensselaer Polytechnic Institute, Troy. New York.



The sewage treatment plant at Jackson, Michigan, employs Alcoa Aluminum diffuser plate holders.

Protect the porosity of your diffuser plates and you maintain aeration tanks at top efficiency. Diffuser plate holders of Alcoa Aluminum are non-rusting; there's no rust-clogging of plates to interfere with their free passage of air.

The Burger design of diffuser plate holder simplifies installation and servicing of plates. Light in weight, these cast Aluminum holders, carrying from one to ten plates each, are handled as a unit. Plates are removed, without danger or breakage, simply by loosening several bolts; quickly replaced and made water- and airtight by durable rubber gaskets.

Construction and maintenance costs are held to a minimum. ALUMINUM COMPANY OF AMERICA, 2108 Gulf Building Pittsburgh, Pa.

ALCOA ALUMINUM

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

SEWERAGE SYSTEM, MINNESOTA

OWNER: City of Wayzata, Minn.; Druar & Milinowski, St. Paul, engineers.

PROJECT: Constructing sewerage system, including sewers (Part I); and treatment plant and lift station (Part II).

CONDITIONS: Project must be completed by Dec. 25, 1939. Contractor to furnish materials. Rail and highway transportation facilities available. Wage rates for the job are: skilled, $1.37½ per hr.; semi-skilled, $1.10; and common (building labor), 85c. per hr.

BIDS: Five bids were received on Part I, ranging from the contract bid, $106,233, to the high of $146,114. On Part II, bids range from $83,442 to $98,009 for the five contractors bidding. Bids opened May 6, 1939.

PART I — SEWERS

LOW BIDDERS:

1. Mariani & Orfei, St. Paul, Minn. (contract) $106,233
2. Theo. Jensen Co., St. Cloud, Minn 111,877
3. Okes Constr. Co., St. Paul, Minn 133,290

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Manholes	143 ea.	$70.00	$90.00	$90.00
2. 6" Vit. Pipe Chimneys	1,800 l. f.	.50	.50	.60
3. 6" Serv. conn. 3'– 7' deep	2,000 l. f.	.70	1.00	.80
4. 6" Serv. conn. 7'– 9' deep	4,000 l. f.	.75	1.05	1.00
5. 6" Serv. conn. 9'–11' deep	1,500 l. f.	1.00	1.25	1.10
6. 6" Serv. conn. 11'–13' deep	500 l. f.	1.15	1.50	1.50
7. 8" Vit. pipe, ld. 0'– 5' deep	300 l. f.	.75	.90	1.00
8. 8" Vit. pipe, ld. 5'– 7' deep	3,400 l. f.	.90	.95	1.00
9. 8" Vit. pipe, ld. 7'– 9' deep	9,500 l. f.	1.05	1.00	1.15
10. 8" Vit. pipe, ld. 9'–11' deep	13,000 l. f.	1.25	1.05	1.30
11. 8" Vit. pipe, ld. 11'–13' deep	6,200 l. f.	1.55	1.10	1.70
12. 8" Vit. pipe, ld. 13'–15' deep	2,200 l. f.	1.95	1.20	2.00
13. 8" Vit. pipe, ld. 15'–17' deep	1,300 l. f.	2.25	1.75	2.20
14. 8" Vit. pipe, ld. 17'–19' deep	600 l. f.	3.00	2.50	3.00
15. 8" Vit. pipe, ld. 19'–21' deep	300 l. f.	3.10	3.00	4.00
16. 8" Vit. pipe, ld. 21'–23' deep	300 l. f.	3.65	3.50	4.40
17. 8" Vit. pipe, ld. 23'–25' deep	500 l. f.	4.05	4.00	4.60
18. 8" Vit. pipe, ld. 25'–27' deep	100 l. f.	4.05	5.00	4.65
19. 8" Vit. pipe, ld. 27'–29' deep	100 l. f.	4.05	6.00	6.00
20. 8" Vit. pipe, ld. 29'–31' deep	100 l. f.	4.05	7.00	7.15
21. 8" Vit. pipe, ld. 31'–33' deep	100 l. f.	5.25	8.00	7.70
22. 8" Vit. pipe, ld. 33'–35' deep	100 l. f.	5.25	9.00	9.30
23. 8" Vit. pipe, ld. 35'–37' deep	100 l. f.	5.25	10.00	10.85
24. 10" Vit. pipe, ld. 7'– 9' deep	100 l. f.	1.15	1.15	1.10
25. 10" Vit. pipe, ld. 9'–11' deep	200 l. f.	1.45	1.20	1.20
26. 10" Vit. pipe, ld. 11'–13' deep	1,000 l. f.	1.75	1.25	1.90
27. 10" Vit. pipe, ld. 13'–15' deep	1,300 l. f.	2.25	1.55	2.00
28. 10" Vit. pipe, ld. 15'–17' deep	500 l. f.	3.05	1.90	2.30
29. 10" Vit. pipe, ld. 17'–19' deep	250 l. f.	3.25	2.60	3.20
30. 10" Vit. pipe, ld. 19'–21' deep	30 l. f.	3.25	3.10	4.60
31. 10" Vit. pipe, ld. 21'–23' deep	10 l. f.	3.75	3.60	5.00
32. 10" Vit. pipe, ld. 23'–25' deep	10 l. f.	4.00	4.00	6.00
33. 10" Vit. pipe, ld. 25'–27' deep	10 l. f.	4.25	5.00	7.00
34. 10" Vit. pipe, ld. 27'–29' deep	10 l. f.	5.25	6.00	8.00
35. 10" Vit. pipe, ld. 29'–31' deep	10 l. f.	5.25	7.00	9.00
36. 10" Vit. pipe, ld. 31'–33' deep	10 l. f.	6.25	8.00	10.00
37. 10" Vit. pipe, ld. 33'–35' deep	10 l. f.	6.25	9.00	12.00
38. 10" Vit. pipe, ld. 35'–37' deep	20 l. f.	7.25	10.00	14.00
39. 10" Vit. pipe, ld. 37'–39' deep	80 l. f.	7.25	12.00	16.00
40. 10" Vit. pipe, ld. 39'–41' deep	50 l. f.	7.25	15.00	18.00
41. 12" Vit. pipe, ld. 9'–11' deep	100 l. f.	1.45	1.30	1.50
42. 12" Vit. pipe, ld. 11'–13' deep	100 l. f.	1.55	1.35	2.00
43. 12" Vit. pipe, ld. 13'–15' deep	500 l. f.	1.85	1.65	2.25
44. 12" Vit. pipe, ld. 15'–17' deep	600 l. f.	2.15	2.00	3.00
45. 12" Vit. pipe, ld. 17'–19' deep	200 l. f.	2.75	2.70	3.50
46. 12" Vit. pipe, ld. 19'–21' deep	100 l. f.	2.95	3.20	4.80
47. 12" Vit. pipe, ld. 21'–23' deep	100 l. f.	3.25	3.80	5.50
48. 6" ex. hvy. C.I. soil pipe	200 l. f.	.90	1.00	1.50
49. 8" ex. hvy. C.I. soil pipe	1,000 l. f.	1.55	1.50	1.60
50. 10" ex. hvy. C.I. soil pipe	100 l. f.	2.00	2.50	3.00
51. 12" ex. hvy. C.I. soil pipe	150 l. f.	2.50	3.25	3.50
52. Bitum. joints, 6 in	3,000 l. f.	.05	.08	.20
53. Bitum. joints, 8 in	15,000 l. f.	.06	.10	.25
54. Bitum. joints, 10 in	3,000 l. f.	.07	.12	.28
55. Bitum. joints, 12 in	1,700 l. f.	.08	.15	.30
56. 5" C.I.P. laid 3'– 5' deep	100 l. f.	1.70	1.50	1.25
57. 5" C.I.P. laid 5'– 7' deep	600 l. f.	1.70	1.85	1.60
58. 5" C.I.P. laid 7'– 9' deep	700 l. f.	1.90	2.00	2.00
59. 5" C.I.P. laid 9'–11' deep	150 l. f.	1.90	2.20	2.10
60. 4" C.I.P. laid	900 l. f.	1.35	1.40	1.25
61. C.I. spec. in place	5,000 lb.	.09	.08	.28
62. 4" gate val., box; inst.	1 ea.	30.00	32.00	50.00
63. Hydrant, installed	1 ea.	85.00	100.00	100.00
64. 6" x 6" Vit. Wyes; placed	5 ea.	1.00	1.00	1.50
65. 8" x 6" Vit. Wyes; placed	700 ea.	1.45	1.10	1.70
66. 10" x 6" Vit. Wyes; placed	40 ea.	2.00	1.60	2.50
67. 12" x 6" Vit. Wyes; placed	20 ea.	2.50	2.00	3.00
68. Tight sheeting	350 M s.f.	15.00	30.00	35.00
69. Sawed lumber	100 M s.f.bm.	30.00	40.00	40.00
70. Sand or gravel lining	200 c. y.	2.25	3.50	3.50
71. Conc. (1:2½:5)	30 c. y.	15.00	23.00	30.00
72. Remov. conc. pavmt	300 s. y.	1.50	.50	1.00
73. Replace conc. pavmt	300 s. y.	3.00	3.00	3.00
74. Excav. loose rock	150 c. y.	3.00	4.50	3.00
75. Excav. solid rock	50 c. y.	5.00	10.00	5.00
76. Remov. unforeseen obstr	200 c. y.	3.00	6.00	5.00

PART II — TREATMENT PLANT AND LIFT STATIONS

LOW BIDDERS:

1. Barnett & Record Co., Minneapolis, Minn. (contract) $83,442
2. Theo. Jensen Co., St. Cloud, Minn 84,547
3. Lindh-Gustafson-Hlopfer Co., Minneapolis, Minn 97,142

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excav	1,000 c. y.	$0.40	$1.00	$0.55
2. Misc. appurten	.....	382.00	400.00	613.00
3. Digest. tank	.....	3,180.00	3,700.00	3,602.00
4. Sludge bed	.....	3,170.00	3,100.00	2,179.00
5. Chlor. chamber	.....	840.00	770.00	999.00
6. Trickl. filter	.....	10,370.00	10,600.00	13,361.00
7. Rock fill, filter	650 c. y.	2.90	3.50	3.70
8. Pump building	.....	5,750.00	6,000.00	6,627.00
9. Prim. clarifier bldg	.....	7,350.00	6,800.00	12,051.00
10. Second. clarifier bldg	.....	6,900.00	6,000.00	7,017.00
11. Dosing tanks and siphon	.....	2,260.00	2,720.00	1,231.00
12. Sand filter	.....	4,450.00	4,500.00	4,862.00
13. Gravel fill, sand fltr	750 c. y.	3.00	3.50	3.80
14. Sand filling	700 c. y.	1.90	4.00	2.10
15. Lift sta. A. and B	.....	10,000.00	7,950.00	7,665.00
16. Pipe, valve, fittings	.....	6,870.00	7,200.00	8,869.00
17. Htg., plumb., vent	.....	4,000.00	5,000.00	6,958.00
18. Sludge pump	.....	535.00	550.00	603.00
19. Sew. pump, tr. plt	.....	295.00	400.00	320.00
20. Sew. pump, lift sta	.....	1,445.00	1,700.00	1,792.00
21. Rot. dist., dosing siphon	.....	825.00	900.00	1,966.00
22. Clarifier mech	.....	2,365.00	2,400.00	2,573.00
23. Iron fence	1,100 l. f.	1.50	1.10	1.00
24. Chlorinator	.....	1,590.00	1,600.00	1,979.00
25. Elec. work	.....	3,350.00	2,347.00	3,500.00

CHANNEL IMPROVEMENT, MICH.

OWNER: U. S. Engineer Office, Detroit; Col. C. R. Pettis, district engineer.

PROJECT: Removal, disposal of approximately 273,000 cu.yd. of ledge rock and 321,700 cu.yd. of material other than ledge rock from Trenton Channel, Detroit River. Length of channel is 15,922 ft. and width is 250 ft. Depth 21 ft. below low water datum. Also includes a trapezoidal turning basin 1,000 ft. wide and 1,350 ft. long. Stipulated contract time is 300 calendar days after receipt of notice to proceed. Transportation by rail, highway and water is available. Ledge rock requires drilling and blasting. Excavated material must be transported and deposited in authorized dumping ground. Material dumped in Lake Erie must be transported in scows around the upper end of Grosse Isle. Other dumping grounds may be used alongside of channel bank of harbor line. A rubble dike is required to confine material on the channel side of Elizabeth Park disposal area. The usual range of water level is 2 ft. as measured by mean monthly stages. River current is normally 1½ m.p.h. Channel in natural condition with scattered boulders.

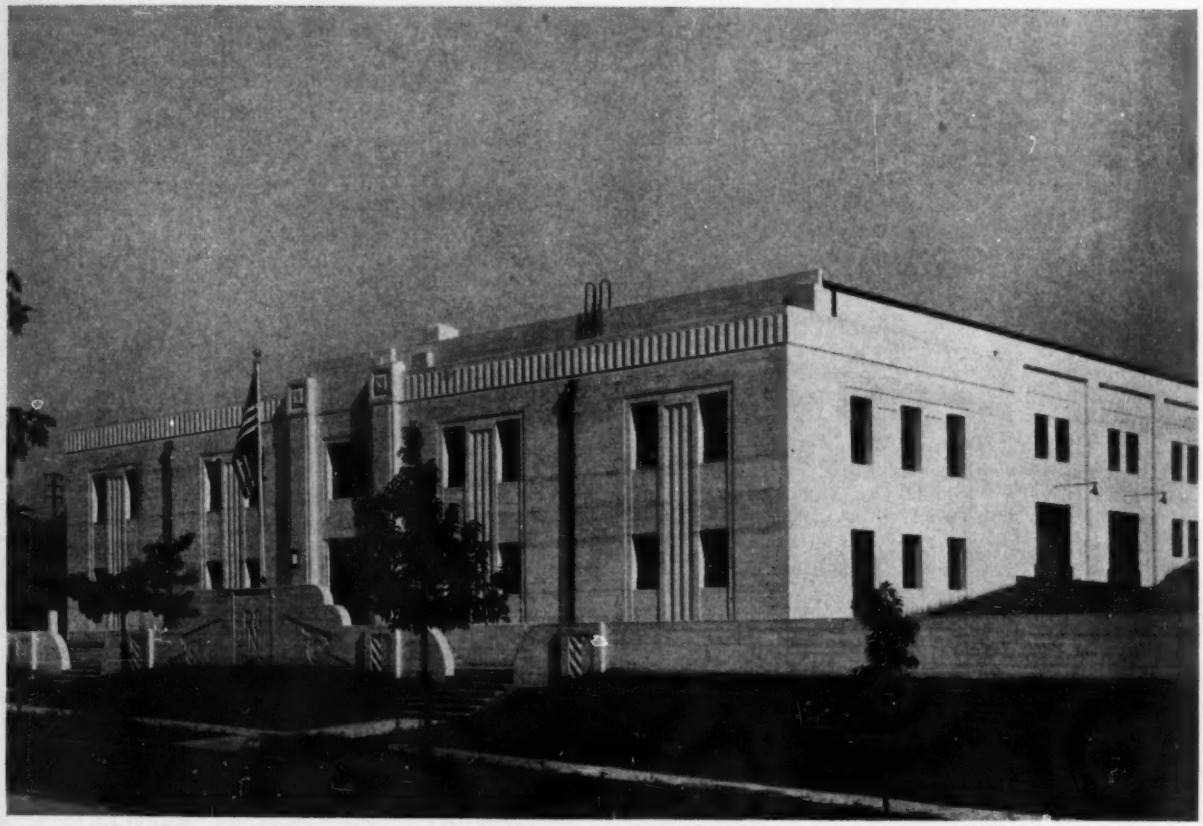
BIDS: Five bids were received Apr. 6, 1939, ranging from the contract low of $868,262 to $980,810. Labor rates are as follows: skilled, $1.50 to $1.875 per hr.; semi-skilled, $1.073 to $1.11 per hr.; common, 70¢ per hr.

LOW BIDDERS:

1. Dunbar & Sullivan Dredging Co., Detroit (contract) $868,262
2. Powers-Thompson Construction Co., Joliet, Ill. 896,475
3. Great Lakes Dredge & Dock Co., Cleveland .. 910,912

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Ledge rock	273,000 c. y.	$1.46	$2.40	$2.85
2. Other material	321,700 c. y.	1.46	.75	.413

(*Contract Unit Prices continued on page 78*)



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(Contract unit prices continued from page 76)

HIGHWAY UNDERPASS PHOENIX, ARIZONA

OWNER: Arizona State Highway Commission, Phoenix, Ariz., W. R. Hutchins, State Highway Engineer.

PROJECT: Construction of underpass structure, approaches and incidental work under railroad tracks at South Central Avenue, Phoenix. Consists of two tunnels, 21 ft. clearance, each to be of road width. Pedestrian tunnels each side of roadway. Underpass 950 ft. long; superstructure 357.6 ft. long.

CONDITIONS: Project is located in center of city, and storage space for materials is limited. Traffic must be maintained throughout construction. All materials to be furnished by contractor. Contract awarded to low bidder on June 1, and must be completed in 1 year. Labor rates on the underpass are: skilled, $1.00 per hr.; semi-skilled, 68¾c. per hr.; and common labor, 62½c. per hr.

BIDS: Ten bids were received on May 16, ranging from the contract low of $178,892 to the high of $219,321.

LOW BIDDERS:

Lee Moor Constr. Co., El Paso, Tex. (contract)	$178,892
Tanner Constr. Co., Phoenix, Ariz.	180,135
W. E. Hall Constr. Co., Phoenix, Ariz.	180,598

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Struct. excav.	24,233 c. y.	$0.61	$0.64	$0.50
2. Aggr. base course	795 ton	1.00	1.00	1.25
3. Sprinkling	390 M gal.	1.00	1.00	1.50
4. Rolling	117 hr.	3.50	3.00	3.50
5. Cl. A conc.	1,111 c. y.	18.00	18.00	18.00
6. Cl. D conc.	2,848 c. y.	18.00	17.00	18.00
7. Reinf.	691,760 lb.	.044	.04	.043
8. Struct. steel	82,771 lb.	.067	.085	.12
9. 6" conc. pavement	3,138 s. y.	2.00	2.60	2.25
10. 6" conc. driveways	143 s. y.	2.00	2.60	2.50
11. Spec. conc. trk. base	50 s. y.	2.00	2.85	3.50
12. 3' valley gutter	420 l. f.	1.15	1.06	1.25
13. Comb. curb. & gutter, Type G	913 l. f.	.90	1.12	1.25
14. Single curb, Type G	84 l. f.	.65	.75	1.00
15. Spec. curb ends & catch basins (comb.)	2 ea.	85.00	65.00	100.00
16. Spec. curb ends	2 ea.	6.00	15.00	50.00
17. Spec. curb castings	6 ea.	25.00	30.00	35.00
18. 4" conc. sidewalk	6,854 s. f.	.19	.19	.20
19. Plant mix (ex. cem. agt.)	902 ton	3.40	3.00	3.50
20. Road oil (pit. mixed oil cake & seal coat)	38 ton	15.00	17.00	18.00
21. Plant mixed seal coat	75 ton	4.00	4.50	5.00
22. 4" vit. clay pipe (open jointed drain tile	4,080 l. f.	.40	.35	.40
23. 8" vit. clay pipe	918 l. f.	1.50	1.85	.65
24. 12" vit. clay pipe	56 l. f.	1.50	1.56	1.25
25. 15" vit. clay pipe	397 l. f.	2.20	2.30	1.75
26. 15" vit. clay pipe (Det. X)	39 l. f.	3.40	3.56	3.00
27. 18" vit. clay pipe	32 l. f.	2.95	3.64	2.75
28. 30" vit. clay pipe	80 l. f.	8.00	7.70	6.50
29. 1" copper pipe	249 l. f.	.60	.90	.50
30. 6" cast iron pipe	258 l. f.	1.60	2.00	1.35
31. Reconst. 6" cast iron wat. main	54 l. f.	.60	1.00	1.00
32. 8" cast iron pipe	26 l. f.	2.30	3.70	2.00
33. Reconst. 8" cast iron wat. main	786 l. f.	.95	1.75	1.25
34. 16" cast iron pipe	85 l. f.	4.85	5.55	6.00
35. 30" cast iron pipe	60 l. f.	14.50	14.40	15.00
36. Std. manhole (No. 1)	8 ea.	160.00	94.00	100.00
37. Std. manhole (No. 2)	4 ea.	265.00	145.00	100.00
38. Manhole (W. U. std.) salv. rings & covers	3 ea.	135.00	106.00	125.00
39. Manhole (M. S. T. & T. Co. std.) salv. rings & covers	3 ea.	155.00	132.00	125.00
40. Reset. manhole cov. to grade	3 ea.	16.00	10.00	10.00
41. Reset drop inlet grates to gr.	2 ea.	16.00	15.00	15.00
42. Reset fire hydrant	1 ea.	50.00	20.00	50.00
43. Std. catch basins (No. 2)	3 ea.	165.00	70.00	50.00
44. Std. catch basins (No. 3)	1 ea.	165.00	80.00	75.00
45. Membrane and asph. plk. waterproofing	L. S.	6,800.00	6,600.00	6,000.00
46. 2" pipe handrail	125 l. f.	1.30	2.00	1.75
47. Fur. & inst. conduit, W. U. cable	L. S.	950.00	1,250.00	900.00
48. Fur. & inst. cond., M.S.T.&T.Co. cables	L. S.	2,000.00	3,282.15	1,250.00
49. 6" copper seal	425 l. f.	.30	.42	.50
50. 8" copper seal & flashing	931 l. f.	.35	.52	1.00
51. Cartouches & portal lettering	L. S.	1,175.00	980.00	1,000.00
52. ½" Gunite (gun finish)	464 s. y.	.50	1.35	1.25
53. Autom. gas. eng. dr. pump, 2000 gpm	L. S.	2,800.00	3,250.00	3,000.00
54. Autom. elect. dr. pump 500 gpm	L. S.	1,400.00	1,250.00	1,250.00
55. Pump house discharge line	L. S.	1,000.00	1,115.00	1,250.00
56. Drainage sys., incl. rdwy. grates & sumps	L. S.	1,600.00	1,600.00	2,000.00
57. Elec. light. system	L. S.	9,500.00	10,000.00	8,000.00
58. Remodel basements	L. S.	800.00	775.00	900.00
59. Remov. pavmt. & driveways	7,770 s. y.	.20	.22	.45
60. Remov. conc. sidewalk	7,915 s. y.	.04	.032	.05
61. Remov. conc. curb & gutter	580 l. f.	.12	.25	.20

HIGHWAYS, WYOMING

OWNER: Wyoming State Highway Commission, Cheyenne, Wyo. W. B. Schilling, Casper, Wyo., engineer.

PROJECT: Base course surfacing and oil treatment by road-mix method of 18.667 miles of the Lander-Muddy Gap Road, Fremont County, Wyoming. 30′ subgrade, 28′ oil mat.

CONDITIONS: Work must be completed 60 working days commencing 20 days after notice of award. Transportation by highway. Materials to be furnished by contractor. Due to the sandy condition of sub-grade for about 8 miles, no base course is to be used. Sub-grade to be treated with MC-2, then oil mat to be put down. Labor rates: skilled, $1.12½ per hr. min.; semi-skilled, 65c. per hr. min.; common, 55c. per hr. min.

BIDS: Six bids were received June 6, ranging from the contract low of $85,151 to the high of $97,053. Engineer's estimate, $89,394.

LOW BIDDERS:

1. Summit Constr. Co., Rapid City, S. Dak. (contract)	$85,151
2. Northwestern Engineering Co., Rapid City, S. Dak.	85,921
3. W. W. Clyde & Co., Springfield, Utah	86,294

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Pit run hvy. base course	1,100 ton	$0.45	$0.55	$0.50
2. Pit run grav. base course	600 ton	.50	.65	.50
3. Cr. grav. base course	8,200 ton	.53	.50	.40
4. Pit run grav. surf. (top)	15,800 ton	.47	.45	.55
5. Cr. gravel surf. (top)	6,810 ton	.60	.50	.45
6. Watering	170 M gal.	3.00	3.00	2.00
7. Roller operation	70 hr.	5.00	4.00	4.00
8. Base treatment (MC-2)	212,500 gal.	.08	.08	.09
9. Seal coat	83,000 gal.	.12	.08	.09
10. Slow cur. liq. asph.	258,000 gal.	.06	.088	.08
11. Process. roadway	317,050 s. y.	.06	.054	.05
12. Shap. and tamp. curb	28,750 l. f.	.10	.12	.15
13. Shap. and tamp. spillway	350 l. f.	1.00	.30	.30
14. Embank. protectors	12 ea.	30.00	20.00	15.00
15. 8 in. C. M.P.	174 l. f.	1.60	1.40	1.25
16. Cl. 1 riprap	20 c. y.	5.00	6.00	5.00
17. Port. snow fence	2,032 l. f.	.90	.80	.75
18. Excav.	600 c. y.	.60	.30	.40
19. Overhaul	1,500 c. y. sta.	.015	.015	.015

FORCE MAINS, WATER SYSTEM OHIO

OWNER: City of Toledo; Greeley & Hansen, Chicago, engineers.

PROJECT: Construction of a steel force main for Toledo's new lake water system, consisting of 44,700 ft. of 78-in. steel or concrete pipe. Contract was awarded on steel construction. Stipulated contract time is 300 days from award of contract. Transportation by rail, highway and water is available.

BIDS: Twenty-seven bids were received Apr. 12, 1939. Labor rates are as follows: skilled, $1.625 per hr.; semi-skilled, $1.50 per hr.; common, 85¢ per hr.

LOW BIDDERS:

1. Magee Co., St. Paul—Steel (contract)	$1,055,528
2. Lock Joint Pipe Co. (concrete)	1,060,686
3. Brandon Reed (steel)	1,084,340

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Fur. and install mains	44,700 l. f.	$23.62	$23.72	$24.22